DECEMBER 13, 1956
EVERY OTHER THURSDAY

MACHINE DESIGN

A PENTON PUBLICATION

DEC 12

Cold Roll Forming

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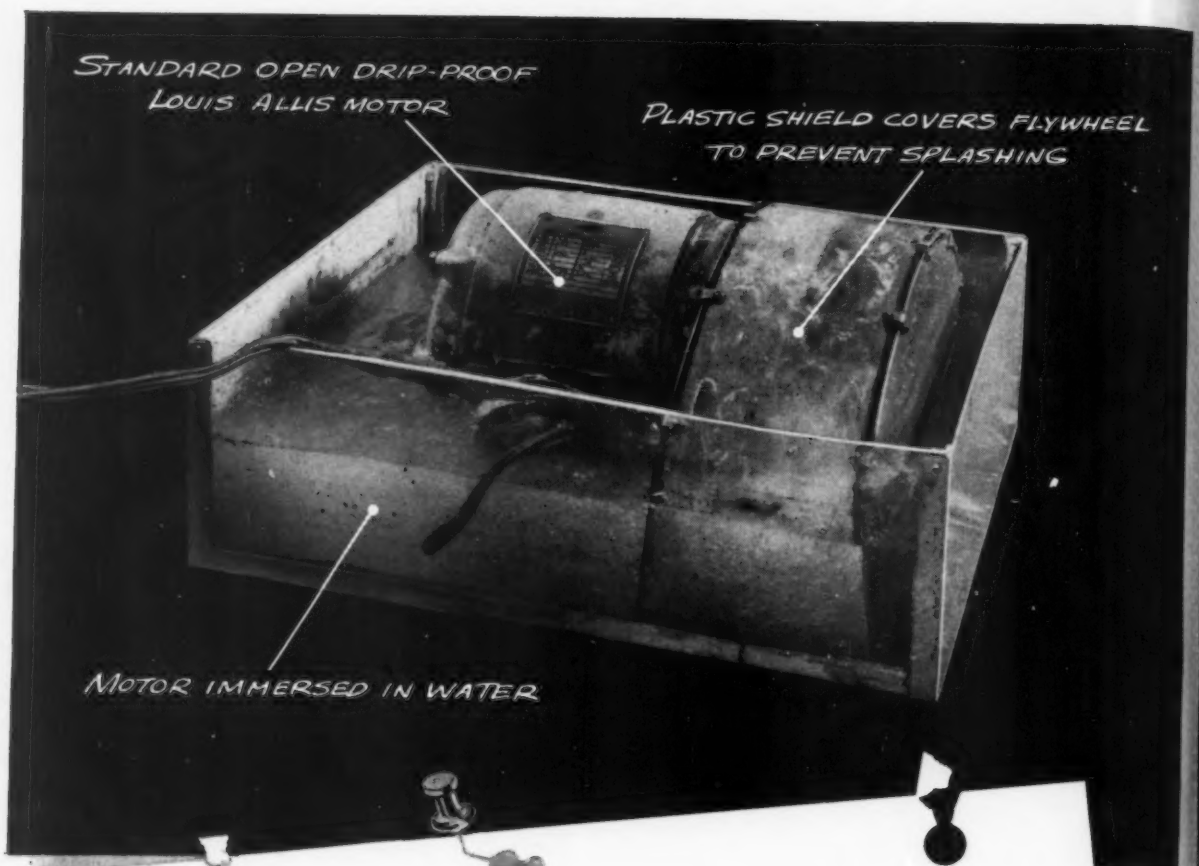

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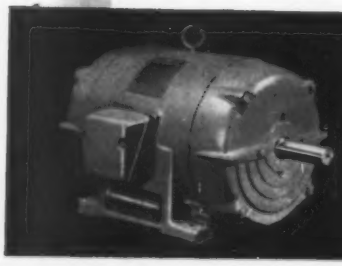

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Circle 504 on page 19

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THE PROFESSIONAL JOURNAL FOR ENGINEERS AND DESIGNERS

MACHINE DESIGN

December 13, 1956
Volume 28—No. 25

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Subscriptions in United States, possessions, and Canada for home-addressed copies and copies not qualified under above rules: One year, $10. Single copies $1.00. Other countries: One year, $25. Published every other Thursday and copyrighted 1956 by Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation publication at Cleveland, Ohio.

When requesting changes of address, etc., please allow four to six weeks for processing.

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BRASS keeps sales up... manufacturing costs down

TURNER IS A LONG-TIME USER OF ANACONDA BRASS ROD AND TUBE— GIVES 10 REASONS WHY—

Blow torches built by The Turner Brass Works, Sycamore, Ill., have a reputation for dependable operation and long life. Since 1871, brass has been used consistently in their construction and has built a quality reputation for Turner. Turner prefers Anaconda Brass as a quality metal and looks to The American Brass Company as a quality source of supply.

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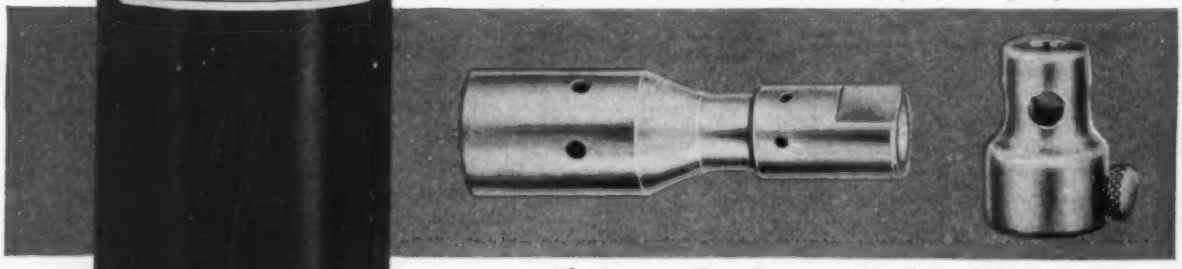
4. Threading holds well—yet accessories are easily screwed on and off.
5. Brass takes a good finish—polishing is easy and economical.
6. Clean, polished brass products have proven high sales appeal.
7. Brass stands up under alternate heating and cooling.
8. Brass resists corrosion—the torches are used on land and sea, throughout the world.
9. Brass gives superior wear on valve seats.
10. Brass has high public acceptance as a quality material.

Turner liquefied petroleum torch No. LP-555, with disposable fuel tank. Below are accessories of brass—holder for soldering tip and a heavy-duty burner.



The American Brass Company, Waterbury 20, Conn.
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Circle 506 on page 19

Engineering News Roundup

Newest Jeep Puts Driver 'Way Up Front

TOLEDO, O. — "Forward control" design is featured in the newest model Jeep recently introduced by Willys Motors Inc. The driver's seat in the new four-wheel drive truck is actually forward of the engine, permitting a view of the road up to 6 ft from the front bumper. Payload bed length behind the cab is more than 6 ft although the truck's wheelbase is only 81 in.

Designated FC-150, the new truck uses the Willys F-head "Hurricane" engine common to both military and civilian model Jeeps. Standard transmission provides nine forward speeds and three reverse. An optional transmission provides 12 forward speeds. Four-wheel drive can be engaged without stopping the truck.

Engine Specifications

Type	OHV, F-Head
No. cyls.	4
Bore & stroke (in.)	3⅛ x 4⅜
Displ. (cu in.)	134.2
Comp. ratio	6.9 to 1*
Bhp, max.	75 @ 4000
Torque, max. (lb-ft)	115 @ 2000

*7.4 to 1 optional.

Size and Weight

Wheelbase (in.)	81
Length (in.)	147½
Width (in.)	71⅜
Height (in.)	77⅜
Curb weight (lb)	2925
Gross vehicle weight (lb)	5000

The FC-150 can be equipped with power takeoff at three points. Center takeoff delivers power to equipment mounted in the truck bed. Front and rear points supply power for winches or belt and shaft-driven equipment.

Turning radius of the FC-150 is 18 ft. Claimed on-highway gas economy is 300 miles on a full tank of 16 gallons.

Newest Jeep is the FC-150 model which places the driver well forward to provide good visibility and to give maximum cargo body length.

THROUGH CONCRETE WITHOUT NOISE this new machine saws holes from 1 to 6 in. in diameter at the average rate of 1 in. per minute. The machine's saw bit is faced with industrial diamonds seated in high-test steel. A built-in counterbalancing device makes external pressure unnecessary. A 115 or 230 v motor drives the new machine made by J. F. Hamlin Co. and called Kor-It.

Future Cars May Have More But Smaller Instruments

Refinements Due In Other Car Accessories

FLINT, MICH. — New instruments for passenger cars of the future may include an indicator for the water level in the cooling system and another for the oil level in the crankcase. These and the present instruments may be smaller than current styles but will give a wider sweep indication, as much as 270 degrees.

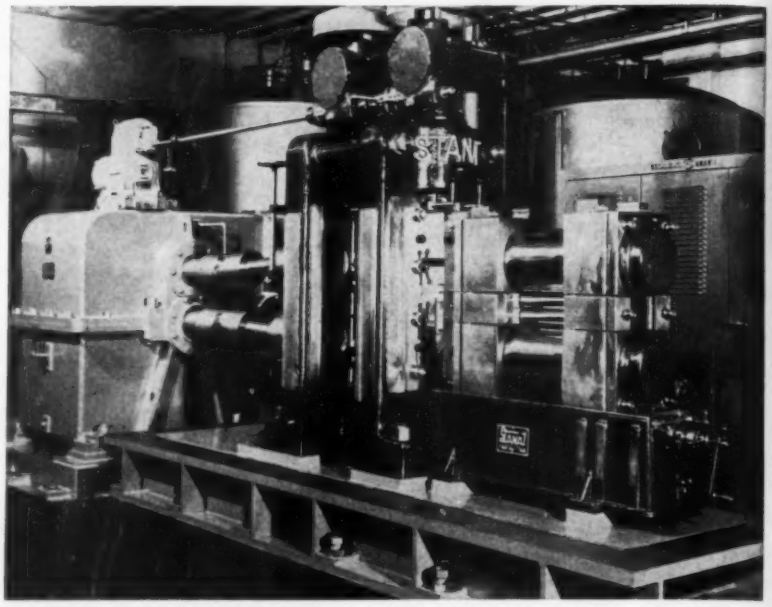
Prospects for the new gages and other automobile accessories were discussed recently by Martin J. Caserio, chief engineer, automotive products, AC Spark Plug Div., at a conference of automotive writers in the main AC accessory plant.

Indicating trends in automotive instrumentation, Mr. Caserio noted that the Redliner-type speedometer introduced in the 1954 Buick has been extended to the Pontiac

line for 1957. Current model Buicks can also be equipped with the Safety-Minder speed warning device. A control knob on the Buick instrument panel can select speeds from 20 to 110 mph in increments of 5 mph. A buzzer sounds when the car reaches the preselected speed. Future models of the Safety-Minder may be set with an insert key.

More extensive use of printed circuits for instrument clusters is a strong possibility. The first application is in the 1957 Oldsmobiles. Electric speedometers are also under development, and new designs of spark plugs will be required for future engines with compression ratios as high as 12 to 1.

Higher performance engines create a demand for higher performance accessories. Two new types of air cleaners have been introduced. One is made of resin-impregnated paper with plastisol end seals. Another uses bonded hog's hair. Fuel cleaners, too, must be improved as a result of the introduction of fuel injection. One model recently developed filters particles as small as 10 microns, and future designs may be required to remove particles as small as 3 microns.



Working section of this rolling mill, including the roll change slide and mechanism, will be completely enclosed when nuclear materials are processed.

Mill Fully Enclosed Will Roll Nuclear Reactor Parts

LONG ISLAND CITY, N. Y.—A completely enclosed working section is the unusual feature of a new rolling mill developed to process dangerous materials for use in nuclear power fuel elements and reactor structures. Built by the Stanat Mfg. Co., two of the new mills will soon be in operation at the Argonne National Laboratory, Lemont, Ill. Materials to be rolled include plutonium, uranium, zirconium, beryllium and thorium.

The machine is a combination 2-high/4-high mill with 2½-in. diam work rolls and 10-in. diam backup rolls. Spindles are capable of transmitting 50 hp at the lowest mill speed of 15 rpm. They drive the backup rolls in 4-high operation and the work rolls, directly, in 2-high operation.

The work zone of the mill will be enclosed in an airtight structure containing a helium atmosphere. Operation and maintenance are performed through arm-length gloves.

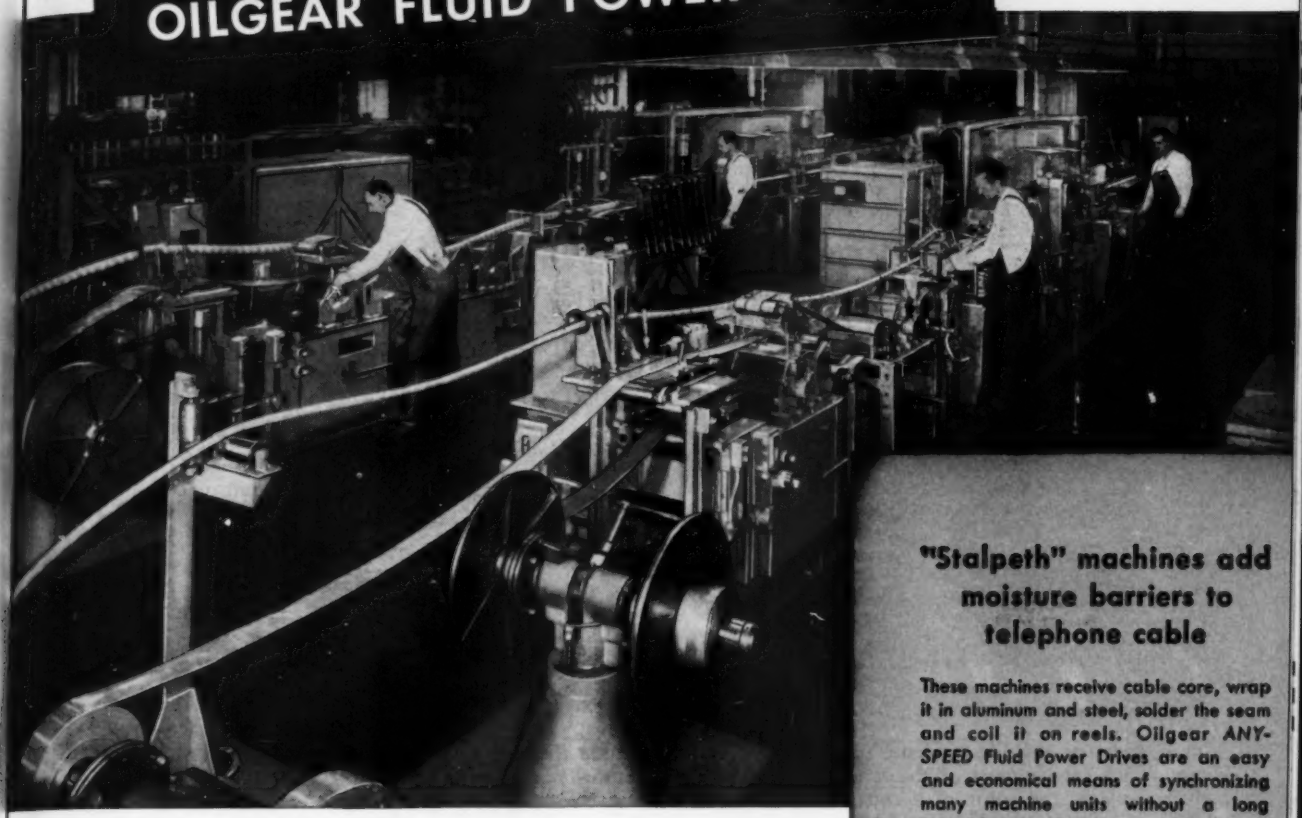
A slideway and slide mechanism in the machine enclosure is provid-

HIGH-SPEED LONG RUNS will be the performance of this new train, called the Speedliner, recently put into regular service on the Baltimore and Ohio Railroad between Philadelphia and Pittsburgh via Washington. Two identical trains starting at opposite ends of the 435-mile run will operate on an 8½-hr all-daylight schedule. Each train consists of three stainless-steel rail diesel cars built by the Budd Co. One of the three is a combined baggage-diner-reclining seat coach, the first in this type of equipment. On each car, two 300-hp diesel engines mounted under the floor transmit power to the trucks through torque converters. The engines can be removed and replaced like spare tires. The train accelerates from 0 to 70 mph in 2½ minutes.

Front Cover

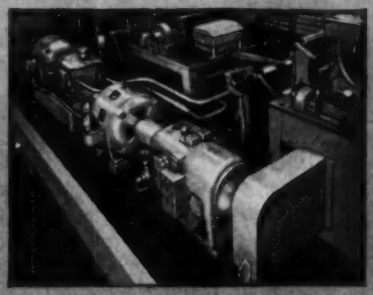
Roll forming, in which a strip of metal is progressively bent by rolls to a final shape, is a continuous, high-speed process. Artist George Farnsworth has emphasized this continuous operation as a keynote for the front cover. Article providing the theme is by Richard T. Angel and begins on Page 106.

OILGEAR FLUID POWER DRIVES

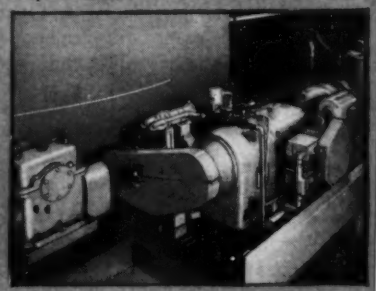


"Stalpeth" machines add moisture barriers to telephone cable

These machines receive cable core, wrap it in aluminum and steel, solder the seam and coil it on reels. Oilgear *ANY-SPEED* Fluid Power Drives are an easy and economical means of synchronizing many machine units without a long lineshaft.



These Oilgear *ANY-SPEED* units drive the aluminum and steel corrugator units in perfect unison with the governing capstan unit.



The Oilgear *ANY-SPEED* capstan drive. Not shown here is another Oilgear unit driving the cable winding reels.

Solving the problem of close synchronization of driven members

As machines become more and more complex, combining more and more functions into a single unit, the problem of driving these machines successfully becomes more difficult.

This problem confronted Western Electric Company engineers in designing what they call their "Stalpeth" machines, two of which are shown above. These machines combine corrugating of steel and aluminum strips, forming them around the cable core, soldering the seam and then winding the assembly on reels at the far end. All of the members of the machine must be synchronized to the speed of the capstan unit. Going by their experience with other somewhat similar machines, Western Electric engineers again turned to Oilgear *"Any-Speed"* Fluid Power Drives, to solve what is really a complex problem ordinarily. Oilgear units provided an easy and economical means of synchronizing many machine components.

Oilgear *Any-Speed* Fluid Power Drives and transmissions *do* offer many machine design advantages including ease of control and synchronization of driven members, steplessly variable speed, fundamentally simple circuits, and long, trouble-free life. Write for Oilgear drive bulletins. THE OILGEAR COMPANY, 1568 W. Pierce St., Milwaukee 4, Wisconsin.

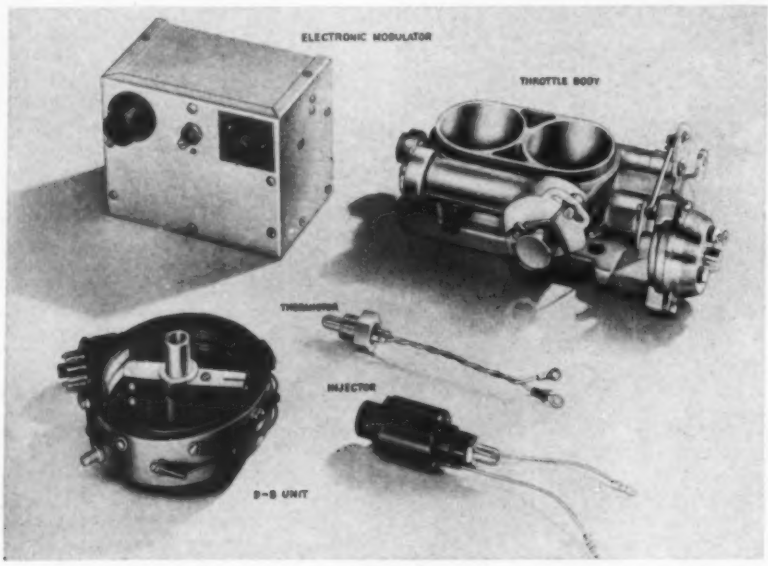
OILGEAR
Fluid Power

PIONEERS . . . NOW THREE PLANTS FOR FLUID POWER

PUMPS, MOTORS, TRANSMISSIONS, CYLINDERS AND VALVES

Circle 507 on page 19

ed for roll changing. A motor-driven screw actuates the slide mechanism which inserts or withdraws the entire roll assembly as a unit. An overhead crane is also available within the enclosure to remove roll assemblies from the roll change slideway.



Components of the Electrojector fuel injection system include the throttle body which carries most of the sensing elements, a distributor-breaker unit which replaces the rotor of a conventional distributor, and the modulator which coordinates the signals and also compensates for altitude.

Fuel Injector for Auto Engines Has Electronic Components

ELMIRA, N. Y.—Electronic components are featured in a new fuel injection system developed by Bendix Aviation Corp. for use on passenger automobiles. Called Electrojector, the system is said to be the first that does not require a special drive off the engine. Current production V-8 engines modified with the Electrojector for test purposes have shown better fuel performance than the same engines equipped with a four-barrel carburetor.

The new injection system consists of an electronic modulator, a fuel-injection distributing commutator, fuel-injection breaker points, and fuel-injection nozzles especially designed to minimize dirt problems.

The timing, sensing, and actuating elements, which automatically control fuel flow to the engine, operate from an electronic pressure sensor located on the throttle body. Also on the body is an electronic switch to sense and signal the need for proper fuel mixture, either for acceleration or idling. A third component on the throttle body is an automatic cutoff switch that should cut down the smog problem created by exhaust gases.

A thermistor is located in the water jacket to sense and pass along temperature data to the electronic modulator for optimum performance in start and warm-up.

The commutator and the breaker points which comprise the distributor-breaker of the new system can be installed on any conventional distributor. They add only an inch to the height of the assembly.

The "brain" of the new system is the transistor-equipped electronic modulator. It receives a timed signal from the distributor-breaker which it coordinates with information from the devices that electronically sense engine operating conditions. The modulator sends action signals continuously to injectors at the intake ports.

Topics

Shorter TV tubes will make possible more compact sets. Expected to find wide use in portable sets, the new tubes are around 5 in. shorter than present types and are considerably lighter. Indications are that smaller size receivers will carry smaller price tags too.

• • •

Edsel, favorite of all rumored names for Ford's Model E, has been announced as the official name for the new line. Commenting on choice of the name, a company official explained that Edsel Ford was primarily concerned with styling and that the new car will establish "a new motif in styling."

• • •

Speed and altitude records have been set by a Sikorsky S-56 twin-engine helicopter. Speed was 162.7 mph; altitude, 7000 ft with a 13,250-lb payload.

• • •

Faster patent processing is the objective of a program begun recently by the U. S. Patent Office. Goal is to reduce the present 3½-year wait for a patent to two years by 1965. Patent Commissioner Robert C. Watson feels that less delay in granting patents will reduce risk of infringement on pending patents and will stimulate invention. Meanwhile the mid-1956 backlog of over 200,000 applications will increase by an expected 80,000 by next June.

• • •

Simplified drafting as a means to cut costs and increase productivity was discussed by General Electric drafting consultant Arthur H. Rau at the Drafting Practices Institute conducted recently by the University of Wisconsin. GE is teaching its 5000 draftsmen new techniques to produce functional drawings in minimum time.

• • •

American Society for Testing Materials has formed a subcommittee to study the effects of nuclear and high-energy radiation on the properties of plastics and electrical insulation. The society's decision to form this committee was based on the fact that existing data in the field of radiation effects on materials are in many cases confusing or contradictory.

Circle 508 on page 19→

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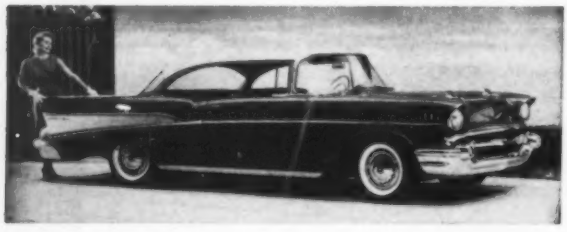
XUM

Rounding Up the 1957 Automobiles—3

THE six automobiles in this issue have the characteristic long, low look for 1957. All but one have been restyled extensively to achieve this effect. Rear fins have been added or have grown; dual headlights can be obtained on some of the cars; windshield area has increased in most models. Several of the cars have pushbutton automatic transmissions; horsepower is higher; four-barrel carburetors are offered as standard or optional equipment; and one make offers a fuel injection system.

CHEVROLET

Twenty different body styles are included in Chevrolet's 1957 line. Seventeen exterior colors, seven of which are new, make possible 16 solid colors and 15 two-tone combinations. The new car is longer and lower than last year's model and has a lowered hood, which permits increased windshield area. A new



ventilating system takes in air through screens over the headlamps and delivers it to the passenger compartment through louvered outlets at each end of the dashboard. Wheels are 14-in. diam.

One six-cylinder and four V-8 engines power the 1957 Chevrolets. Available on any model, the 283-hp Corvette engine introduces Ramjet fuel injection.

Engine Specifications

Type	In-Line	OHV, Vee	OHV, Vee
No. cyls	6	8	8
Bore & stroke (in.)	3.56 x 3.94	3.75 x 3.00	3.87 x 3.00
Displ. (cu in.)	235.5	265	283
Comp. ratio	8.0 to 1	8.0 to 1	8.5 to 1*
Bhp, max	140 @ 4200	162 @ 4400	185 @ 4600
Torque, max (lb-ft)	210 @ 2400	257 @ 2400	275 @ 2400

*9.5 to 1 with four-barrel carburetor, dual four-barrel carburetor or fuel injection.

Size and Weight

Wheelbase (in.)	115.0
Length (in.)	200.0
Width (in.)	73.9
Height (in.)	59.9
Weight (lb)	3290

In operation, the accelerator pedal controls the volume of air; the air volume in turn determines the amount of gasoline delivered through the nozzles of the injector. A high-pressure pump, submerged in a fuel reservoir and driven by the distributor, supplies the pressure behind the gasoline.

New Turboglide transmission, consisting of three turbines and two planetary gearsets combined with a variable-pitch stator and the conventional torque converter pump, provides uninterrupted driving force at all speeds. This transmission has a hill retarder position, whereby a turbulence is created in the oil in the converter to impart a drag on the rear wheels. Powerglide, overdrive, and manual gearshift continue to be available.

LINCOLN

Seven models comprise the Lincoln line for 1957. A four-door hardtop, called the Landau, and a thin pillar sedan are available in both the Premiere and Capri series. There is also a hardtop coupe in both series and a convertible in the Premiere series. The thin pillar sedans look like four-door hardtops when the side windows are rolled up. When the windows are turned down, a thin chrome pillar is visible.

Distinguishing feature of 1957 Lincolns are four

Engine Specifications

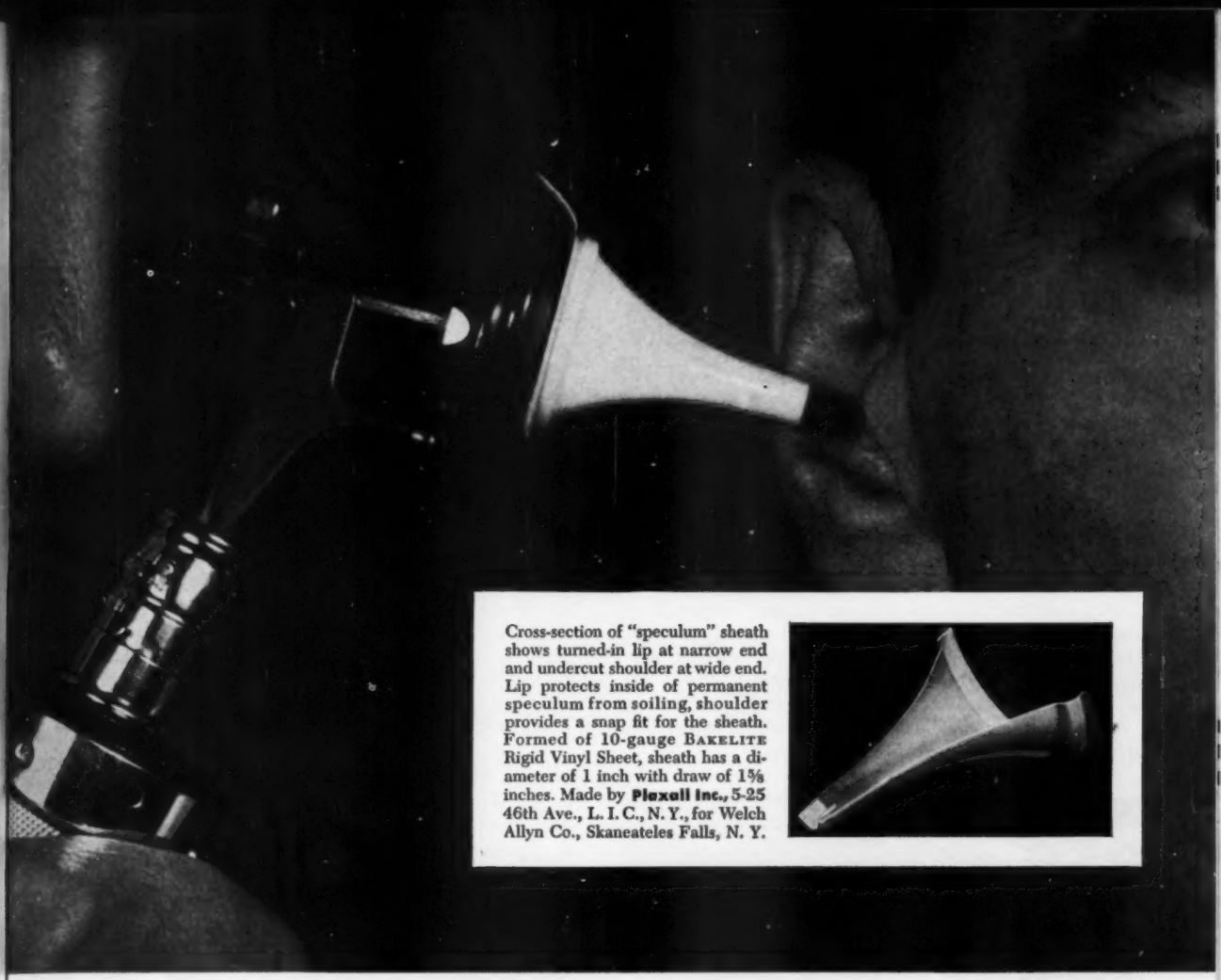
Type	OHV, Vee
No. cyls	8
Bore & stroke (in.)	4.00 x 3.66
Displ. (cu in.)	368
Comp ratio	10 to 1
Bhp, max	300 @ 4800
Torque, max (lb-ft)	415 @ 3000

Size and Weight

Wheelbase (in.)	126
Length (in.)	224.6
Width (in.)	80.3
Height (in.)	60.2
Weight (lb)	4500

road lights in vertical pairs, called Quadra-Lites. The auxiliary road lamps, positioned below the headlights, are optional equipment and may be used either alone or with the headlights.

Compression ratio and horsepower rating in the new Lincolns are both higher than in 1956 models, but engine displacement remains at 268 cu in. A new four-barrel carburetor has larger float bowls, and



Cross-section of "speculum" sheath shows turned-in lip at narrow end and undercut shoulder at wide end. Lip protects inside of permanent speculum from soiling, shoulder provides a snap fit for the sheath. Formed of 10-gauge BAKELITE Rigid Vinyl Sheet, sheath has a diameter of 1 inch with draw of 1⅝ inches. Made by **Plaxall Inc.**, 5-25 46th Ave., L. I. C., N. Y., for Welch Allyn Co., Skaneateles Falls, N. Y.

BAKELITE Rigid Vinyl Sheet makes possible this

Intricate, accurate, disposable part

The design idea is a reality because BAKELITE Brand Rigid Vinyl Sheet was the only material that could be vacuum-formed to so deep a draw, according to the manufacturer. It's a sanitary disposable sheath for the "speculum" of an "otoscope" used in ear examinations.

These sheaths cost only a little over a cent apiece because pressure-forming BAKELITE Rigid Vinyl Sheets is such a fast, low-cost process. Notice the deep, complex draw. Precise, too. The sheath works in close quarters. It has to be thin, tight-fitting, and strong enough to be snapped onto the speculum without crinkling or tearing.

One material—BAKELITE Rigid Vinyl Sheet—met all requirements. In addition, its service properties include *dimensional stability* and resistance to water, oil, and chemicals. Clear transparent, as well as colored translucent and opaque sheet stock is available. Learn more about it by writing Dept. VU-103.

BAKELITE BRAND PLASTICS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC.

Circle 509 on page 19

XUM

ignition timing at all engine speeds has been improved through a new distributor.

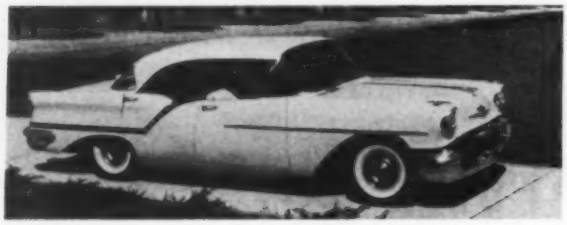
Power brakes are standard equipment on all seven models. In the Premiere and Capri series, power steering and Turbo-Drive transmission are standard. The Premiere also has a four-way power seat and power windows as standard equipment.

Optional accessories in both series are a six-way power seat, electric door locks, pushbutton lubricator, power-directed differential, and air conditioning.

OLDSMOBILE

The 1957 Oldsmobile line consists of three series of cars in 17 body styles. Four body styles are new—three Fiesta station wagons and an "88" convertible coupe. The cars are 2 in. lower and 5 in. longer than last year's models.

Other styling changes include wider bumpers front and rear, two rows of beading on the roof and rear deck, sculptured rear fenders, and parallel chrome strips along the side with a contrasting color paint between. This "accent stripe" is the dividing line on two-tone models and is available in eight colors, six of which are also used as body colors.



Engine Specifications

Type	OHV, Vee
No. cyls	8
Bore & stroke (in.)	4 x 3⅛
Displ. (cu in.)	371
Comp. ratio	9.50 to 1
Bhp, max	277 @ 4400
Torque, max (lb-ft)	400 @ 2800

Size and Weight

	Golden Rocket "88" Series	Super "88" Series	Starfire "98" Series
Wheelbase (in.)	122	122	126
Length (in.)	208.2	208.2	216.7
Width (in.)	76.4	76.4	76.4
Height (in.)	58.2	58.2	58.2
Weight (lb)	4000	4049	4347

The new Oldsmobile's instrument panel is mounted on struts and is the width of the car's body. This type of mounting provides a setback from the base of the windshield to allow air circulation and to provide maximum driver accessibility to the instruments. The instrument cluster employs a printed circuit, which reduces the number of electrical connections from 14 to one. A printed circuit is also used in the radio that is available for these cars.

Frame of the 1957 Olds is 8 in. wider than that of the 1956 model. It is also heavier. Front suspension is designed to prevent brake dip. Rear shock absorbers are positioned outside the leaf springs to provide a wider spring base and to reduce roll on curves. Wheels are 14 in. diam. The four-barrel quadri-jet carburetor is standard on all series.

MERCURY

The 1957 Mercury is distinguished by a low silhouette, a larger body, a choice of two engines, and air-cushion rear suspension on many models. A total of 15 models are available in Monterey, Montclair and station wagon series.

The air-cushioned rear suspension is featured on all six station wagon models and is available on all other models with the optional 290-hp engine except the convertible. An air cushion the size of a tire 6 in. by 1½ in. is inserted between the frame and the front eye of the rear spring.

Other features contributing to riding qualities are longer front and rear springs, and a wider and heavier frame. Chassis features include a heavy straddle-mounted rear axle, low-pressure tires on 14-in. rims, longer wheelbase, wider front tread and wider brakes.

The compression ratio of 9.75 to 1 is the highest of any Mercury engines. The 290-hp engine with automatic transmission is optional on all 1957 models. The 255-hp engine is standard. Both engines have a four-barrel carburetor.

Keyboard automatic transmission control is standard on Montclair models and on Voyager and Colony

Engine Specifications

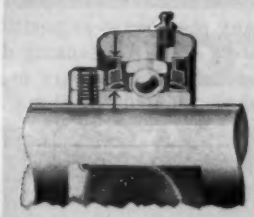
	Safety-Surge	Turnpike Cruiser
Type	OHV, Vee	OHV, Vee
No. cyls.	8	8
Bore & stroke (in.)	3.80 x 3.44	4.00 x 3.66
Displ. (cu in.)	312	368
Comp ratio	9.75 to 1	9.75 to 1
Bhp, max.	255 @ 4600	290 @ 4600
Torque, max (lb-ft)	340 @ 2600	405 @ 2800

Size and Weight

	Monterey and Montclair Models	Station Wagon
Wheelbase (in.)	122	122
Length (in.)	211.1	212.3
Width (in.)	79.2	79.2
Height (in.)	57.0	58.3
Weight (lb)	4000*	....

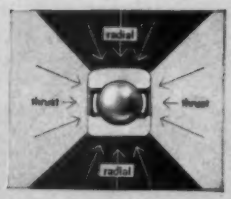
*With automatic transmission and 290-hp engine.

MORE FACTS on why more and more leading manufacturers choose Link-Belt bearings



POSITIVE PROTECTION from moisture, dust and dirt is provided by self-aligning seals extending from housing to inner ring. Aligning surfaces are enclosed and lubricated, assuring free alignment.

AUTOMATIC RELIEF OF EXCESS GREASE PRESSURE is provided through lubrication fitting and patented seal arrangement. Extra large grease capacity extends lubrication intervals.



HIGHEST CAPACITY available to carry radial, thrust or combination radial-thrust loads is provided by single-row, deep-groove design.

RUGGED HOUSINGS result from superior foundry practices. Base is cored to assure stress-free, maximum-strength casting.

DIRTY CONDITIONS around this portable asphalt mixer manufactured by K. E. McConnaughay Co., Lafayette, Ind., make Link-Belt ball bearings the logical choice.

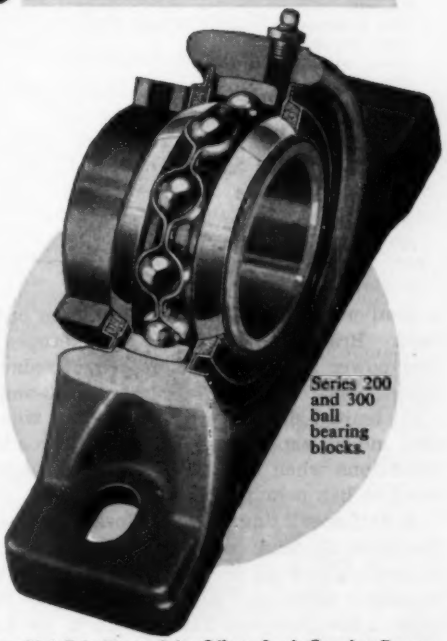
grease stays in, dirt out

thanks to the effective sealing of Link-Belt ball bearings

HERE'S an important extra only Link-Belt gives you on ball bearing blocks! *It's an exclusive seal arrangement*—all aligning surfaces as well as rolling elements are fully lubricated and sealed, assuring long, maintenance-free performance.

All seals are self-aligning—extra assurance that grease stays in, dirt stays out, regardless of alignment. The single-row bearing, too, is self-aligning—in all directions. Free rolling and full load capacity are maintained despite shaft deflection or misalignment.

Both Link-Belt ball and roller bearings offer the "fully-protected" sealing feature. Choose from industry's most complete line of pillow blocks, flange, flange cartridge, cartridge, takeup and hanger blocks. Ask any one of the 40 Link-Belt offices for Data Book 2550.



Series 200 and 300 ball bearing blocks.

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.989-A

XUM

Park station wagons. A combined Neutral/Start button takes the car out of any previous gear position and starts the motor. A safety electrical sensing device prevents engagement of the reverse gears even if the reverse button is pushed accidentally above 10 mph.

CONTINENTAL

Outward appearance of the 1957 Continental Mark II is virtually identical to the 1956 model. Four new iridescent colors are offered. As previously, 14 single shades and 5 two-tone combinations are available.

Mechanical changes in the car have been made to add power and improve acceleration. Compression ratio has been increased to 10 to 1 by redesign of the combustion chambers and reshaping of the pistons. A new carburetor has larger volume float bowls. The transmission uses a steel torque converter having

Engine Specifications

Type	OHV, Vee
No. cyls	8
Bore & stroke (in.)	4.00 x 3.66
Displ. (cu in.)	368
Comp. ratio	10 to 1
Bhp, max	*

* Not available.

Size and Weight

Wheelbase (in.)	126
Length (in.)	218.4
Width (in.)	77.5
Height (in.)	56
Weight (lb)	4797

a smaller diameter than the aluminum one previously used. Brake linings have been improved, and modified power steering control springs reduce effort required for steering. The car has a 40-amp generator.

A limited-slip differential checks wheel spinning and sudden shock loads over uneven roads and under conditions when one wheel leaves the surface of the road or has poor traction.

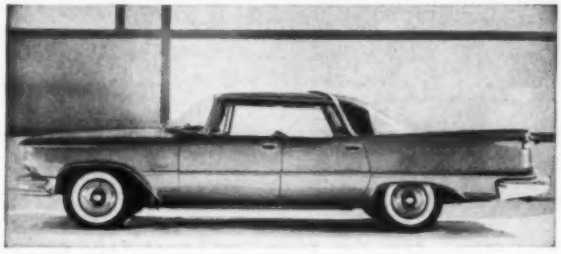
A self-regulating electric clock is new on the 1957 Continental, and an automatic headlight dimmer is available as an accessory. The optional air conditioning system has been redesigned to place the intake in the front end rather than in the leading edges of the rear quarter panels. Air now comes from the fresh-air duct in the engine compartment. Roof registers at each of the four passenger locations may be adjusted individually to control amount of incoming air and direction of flow.

IMPERIAL

Chrysler's luxury automobile, the Imperial, is available in four series for 1957. The Imperial series consists of a four-door sedan and two and four-door hardtops. To these body styles the Crown series adds a convertible coupe—the first Imperial convertible made since 1951. The remainder of the line is comprised of the LeBaron, a four-door sedan, and the Imperial Limousine.

Styling features include longer, lower lines with more head room and leg room than last year's models provided; dual headlights, which are optional in states where legal; a four-way wraparound windshield; and curved glass in the side windows. Hardtops have large, sloping wraparound rear windows. The rear deck is low and slopes downward between outward-canted tail fins. A molded spare tire impression in the deck lid is optional.

A six-way power seat is standard on the LeBaron and Crown series, optional on the Imperial series. Standard equipment on all series includes TorqueFlite transmission, power steering, power brakes, power



Engine Specifications

Type	OHV, Vee
No. cyls	8
Bore & stroke (in.)	4.0 x 3.9
Displ. (cu in.)	392
Comp. ratio	9.25 to 1
Bhp, max	325
Torque, max (lb-ft)	430 @ 2800

Size and Weight

Wheelbase (in.)	129.0
Length (in.)	224.0
Width (in.)	81.2
Height (in.)	56.7
Weight (lb)	4640

radio antenna, foot-operated parking brake, and dual exhausts. Front suspension is ball-joint, torsion-bar type, and the cars ride on low-pressure, 14-in. tires.

The TorqueFlite transmission, which was introduced in the 1956 model year, combines a high-performance torque converter with an automatic three-speed planetary gear box. Transmission control is through a five-button panel to the left of the steering column.

News Roundup

Machine Tool Industry Grows Faster Than Nation's Economy

CHICAGO, ILL. — Production of new machine tools has increased twice as fast as the gross national product in the past five years. This was the recent observation of Louis Polk, president of the National Machine Tool Builders' Association.

Mr. Polk said that machine tool builders have nearly tripled their annual volume of shipments from $305 million in 1950 to $860 million five years later. In the same period, gross national product has increased about 1½ times.

Surveys show that metalworking industries served by the machine tool industry will expand 20 per cent by 1960 and another 20 per cent by 1965.

"No matter how our country's growth is projected," Mr. Polk said, "whether in terms of aircraft, new highways or TV sets and other consumer or durable goods, these products will only be produced by and flow from machine tools."

Heat Radiation To Help Enable High Speed Flight

SAN FRANCISCO, CALIF. — An aircraft of the future passing through the sky at eight times the speed of sound will glow red and radiate enough heat for 400 average size homes. This was the recent prediction of Maury Sulkin, chief thermodynamicist for North American Aviation Inc.

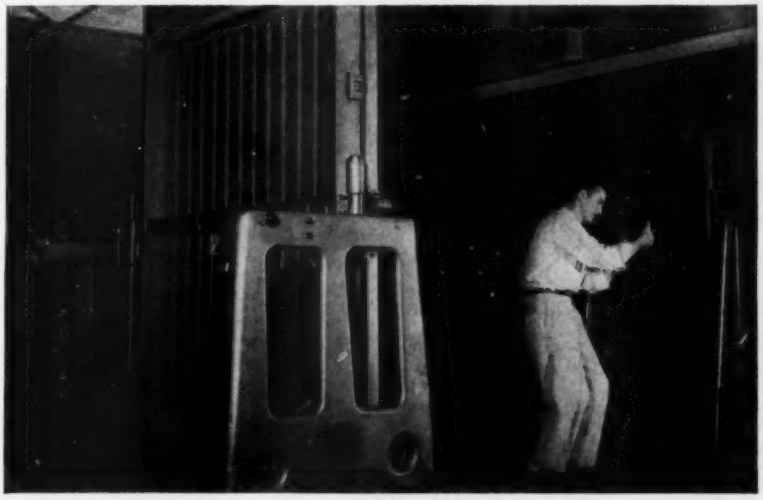
At 5000 mph, Mr. Sulkin said, the plane would be subjected to temperatures of 6000 F were it not radiating enough of its own heat to reduce its skin temperature to 800 F.

"Up to now little consideration has been given to this phenomenon — equilibrium temperature. This has made the so-called thermal barrier into a mysterious obstacle that appeared impossible to hurdle. Actually it's not a true barrier at all, but a steep uphill climb."

Mr. Sulkin proposed establish-

(*Continued on Page 22*)

DRAFTING TRENDS



A good cameraman is one key to making high quality cloth reproductions.

Cloth reproductions safeguard originals, save drafting time

Many priceless original drawings are subjected to constant punishment. Corners become dog-eared (from filing and handling) and base stock is abused through repeated erasures when elements must be redrawn. In addition, drawings are prematurely aged and discolored as they go through a reproduction machine time after time.

An increasing number of plants are turning to reproductions on durable cloth stock to protect original drawings. The cloth repro is actually a "duplicate original." It can be repeatedly erased, corrected, intensified, redrawn, used for further printmaking. Negatives can be assembled with sections from other drawings. Expensive original drawings can thus be permanently and safely stored.

How photography improves worn original drawings

Since one method of producing a cloth reproduction is via photography, good camera work improves original drawings in several ways. Weak, fuzzy lines are intensified. Differences in strength of lines are often equalized. Faded or weak areas can be strengthened.

Even *after* an original drawing has been photographed, it can still be improved. A good retoucher can bring back parts of the original drawing. Background smudges or tape marks can be blocked out to give good, clear, clean prints.

By using photographic techniques, cloth repros can be *better than the original.*

Cloth repros simplify enlarging, reducing

Photographic enlargement or reduction to scale eliminates much routine work. By turning details over to the camera and an experienced staff, draftsmen are released for more important layout and design work. Often in a matter of one or two days, you can have a drawing enlarged or reduced to the desired size on a cloth base *without losing valuable drafting time.*

More information on cloth reproductions and a sample print are available from the Reader Service Division of the Frederick Post Company, 3652 N. Avondale, Chicago 18, Illinois.

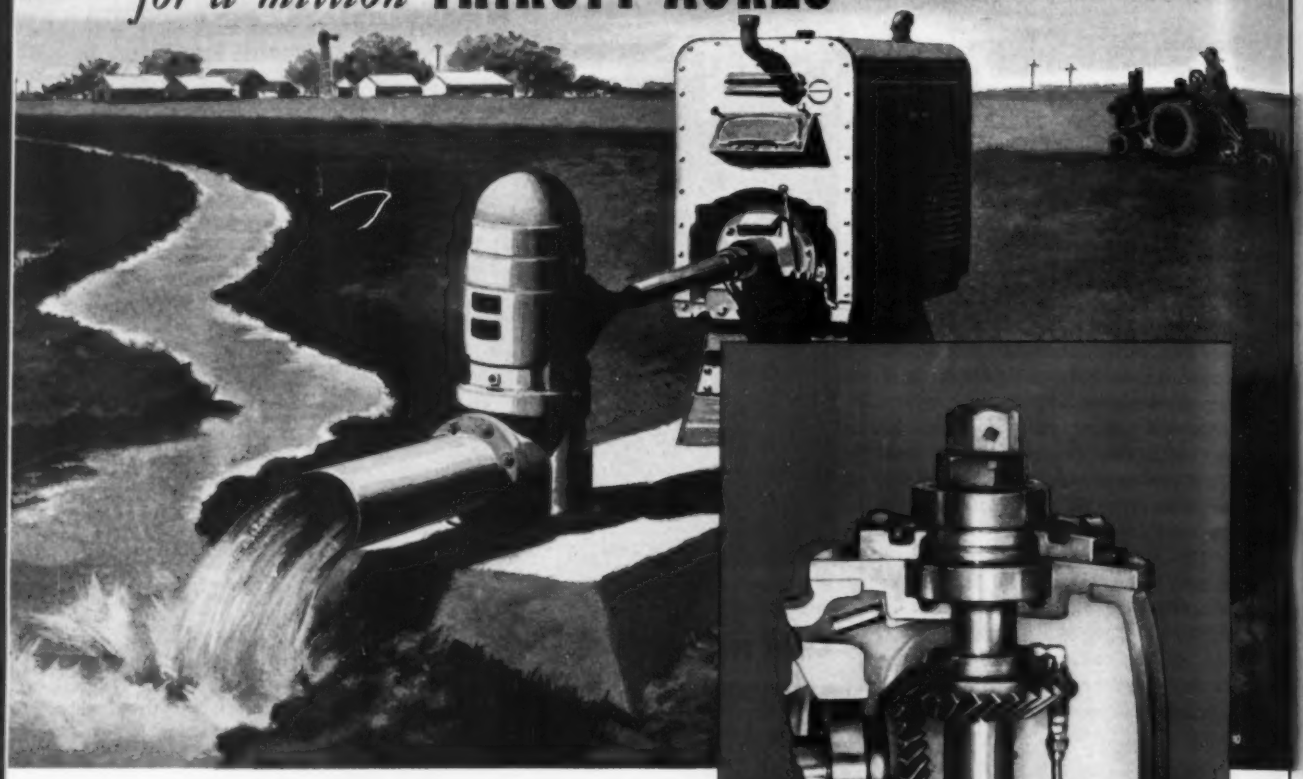
POST

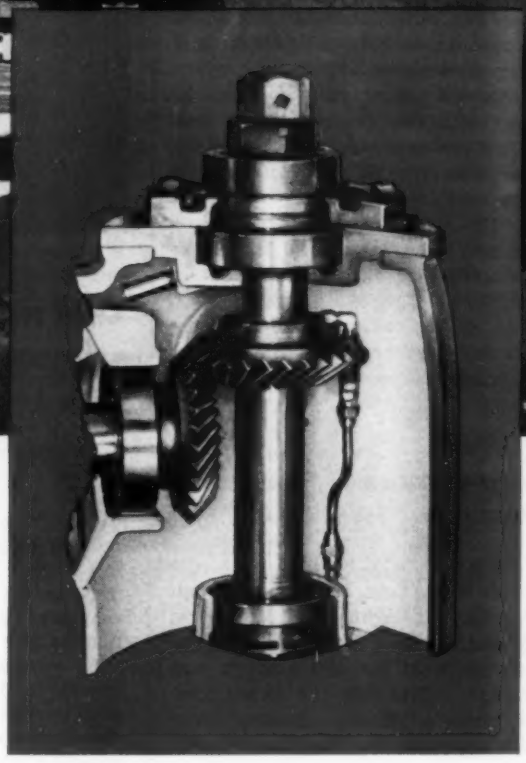
SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

Circle 511 on page 19

XUM

Turning POWER *into* WATER *for a million* THIRSTY ACRES





Here is work—hard work—needed work, for America's huskiest pumps. Here, where crops and livelihood depend upon them, you will find pumps engineered for the most reliable performance and endurance. One of the strongest points we can make about our gear drives is that they are specified as original equipment in the irrigation pumps of many manufacturers.

What is your power transmission problem? Why not write?

Cut-a-way shows gears of our manufacture in a typical heavy-duty irrigation pump.

DOUBLE DIAMOND GEARS

FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

Automotive Gear Works, inc.

ESTABLISHED IN 1914 — RICHMOND, INDIANA

SUBSIDIARY OF EATON MANUFACTURING COMPANY

Circle 512 on page 19

MACHINE DESIGN
READER SERVICE

Reader Information Service

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USE A YELLOW CARD *for More Information . . .*

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EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

Index to New Parts & Helpful Literature

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MACHINE DESIGN
DEC. 13, 1956

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401	426	451	476	501	526	551	576	601	626	651	676	701	726	751
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407	432	457	482	507	532	557	582	607	632	657	682	707	732	757
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415	440	465	490	515	540	565	590	615	640	665	690	715	740	765
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417	442	467	492	517	542	567	592	617	642	667	692	717	742	767
418	443	468	493	518	543	568	593	618	643	668	693	718	743	768
419	444	469	494	519	544	569	594	619	644	669	694	719	744	769
420	445	470	495	520	545	570	595	620	645	670	695	720	745	770
421	446	471	496	521	546	571	596	621	646	671	696	721	746	771
422	447	472	497	522	547	572	597	622	647	672	697	722	747	772
423	448	473	498	523	548	573	598	623	648	673	698	723	748	773
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FIRST CLASS
Permit No. 36
CLEVELAND, OHIO

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed In the United States

—4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Cleveland 13, Ohio

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FIRST CLASS
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CLEVELAND, OHIO

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IF EXTREME ACCURACY IS IMPORTANT . . IT'S A JOB FOR

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Here at G.S., 40 years of specialization and research have resulted in a degree of accuracy *you never thought possible* in the mass production of Small Gearing. If your needs call for hundreds or thousands, however simple or intricate, you'll get Gearing that meets the most exacting specifications, *in every piece we ship.* ★ Think of the assembly costs that cuts . . the increased production . . the smoother, quieter performance . . the greater satisfaction of users . . the greater profit to yourself. ★ Let capable G.S. engineers recommend the ONE best and most economical application for the job. Send drawings or details today. There's no obligation.

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40 Years of Specializing in Small Gearing!

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2244-M Alcoa Bldg., Pittsburgh 19, Pa.

Gentlemen:
Please send complete specification data and samples of your aluminum fasteners.

Name _____

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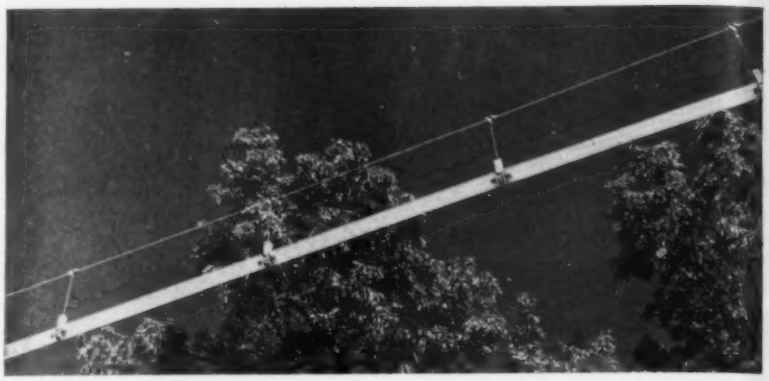
Engineering News Roundup



UNIFORM HIGHWAY LIGHTING is the objective in this experimental installation of G-E fluorescent luminaires. A continuous row is parallel to the curb, 25 ft above the pavement. Fluctuations in brightness and the consequent discomfort of night driving are claimed virtually eliminated.

(*Continued from Page* 15)

ment of a "Thermal Mach Number Spectrum" which divides the speed ranges of aircraft into areas in which problems of heat can best be examined. He said problems of the first speed range—up to Mach 2—offer little difficulty to the heat engineer.

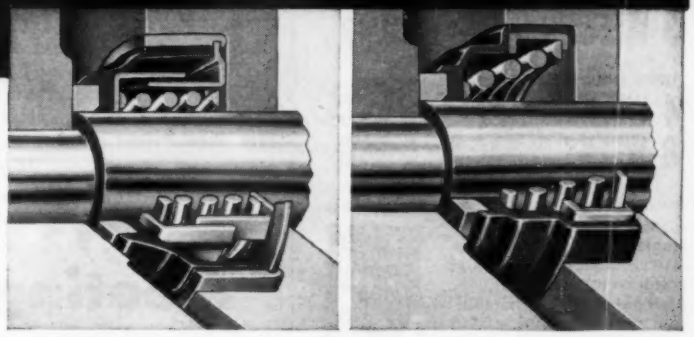
At speeds from Mach 2 to Mach 4 aerodynamic heating assumes great importance in aircraft design. "In the third or 'superthermantic' region—up to eight times the speed of sound—temperatures hotter than an acetylene flame will be reached."

"Above Mach 8 we may reach

MAN-SIZE SIX-SHOOTER is the "Ontos" track-laying hit-run weapon, first production models of which have been built by Allis-Chalmers and delivered to the Marine Corps. The Ontos mounts six 106-mm recoilless rifles, one 30-caliber machine gun and one 50-caliber spotting rifle which support the claim that it is more heavily armed than any other combat vehicle. Ontos carries a crew of three: driver, gunner and ammunition loader. With a six-cylinder, 145-hp, water-cooled engine, Ontos reaches 30 mph and climbs a 60 per cent grade. Total weight, combat loaded, is about 8½ tons.

NOW-3 new developments in axial face sealing for rotating shafts

Victo-Seal Type 2
Highly effective for rotating shaft applications on shallow well pumps, rotary compressors, etc. Utilizes stationary mating seal ring; also can seal against end plate with proper finish.



Victo-Seal Type 3
End face seal unit with metal O.D. for sealing against suitably finished mating surface. For press fit applications in pumps, machine tool applications, automotive equipment, etc., on shaft diameters of .312 to 1.000 in.

Now—water pumps and household appliances, automotive and other industrial equipment for handling fluids can all be sealed more securely and dependably than ever before.

New and exclusive Victo-Seal design—with Victoprene elastomer—assures it!

Victo-Seal incorporates the latest thinking in axial face shaft seal engineering. With the NEW positive torque lock, it eliminates diaphragm fatigue and maintains constant unitary function. Victo-Seal is self-aligning; it compensates automatically for wear, shaft movement and insulates against vibration. Its long-life compression spring provides controlled pressure contact between sealing surfaces.

What's more, each type Victo-Seal is a simple, self-contained unit—moderately priced, and easily and economically installed on the production line or in the field.

Literature available through your Victor Field Engineer, or on request to: Victor Mfg. & Gasket Co., P. O. Box 1333, Chicago 90, Ill. In Canada: Victor Mfg. & Gasket Co. of Canada Ltd., St. Thomas, Ont.

Victo-Seal Type 6
A highly economical end face seal with Victoprene outside diameter assures ease of installation and removal. Metal parts are completely encased in and seal ring bonded to Victoprene diaphragm. Extensively used in the appliance industry.

VICTOR

Sealing Products *Exclusively*

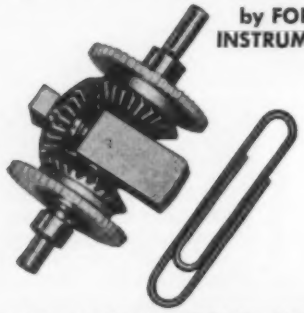
GASKETS • OIL SEALS • PACKINGS • MECHANICAL SEALS

Circle 515 on page 19

ON THE SHELF!

SINGLE SPIDER GEAR DIFFERENTIALS

by FORD INSTRUMENT



AVAILABLE IN FOUR SIZES:
⅛", 3/16", ¼", and 5/16" Shaft Diameters

NOTE! Prices of ⅛" units have been drastically reduced.

GUARANTEED SHIPMENT WITHIN:

(WITHOUT END GEARS)		TYPE
1 WEEK	for units with set shaft lengths*	A
3 WEEKS	for units with shaft lengths to customer specs	B
(WITH END GEARS)		
4 WEEKS	for units with stock end gears	C
8 WEEKS	for units with end gears to customer specs	D

(SUBJECT TO PRIOR SALE)

*Note: 3/4" units are not stocked with set shaft lengths.

Ford Instrument produces single spider gear differentials to highest military and commercial standards, for *extreme accuracy* in addition and subtraction, and in servo loop applications. Seven ways superior. Call or wire W. Mohr, Component Sales Division (STillwell 4-9000) for prices, or check and mail coupon below, stating quantity. Data bulletin with performance curves and characteristics will be sent with the prices.

Component Sales Division MD

FORD INSTRUMENT COMPANY

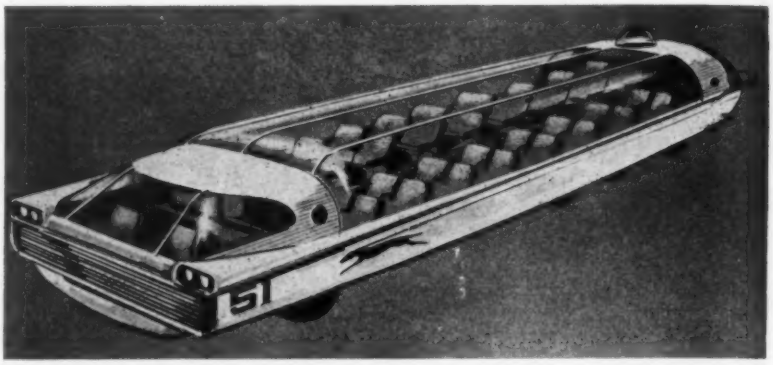
DIVISION OF SPERRY RAND CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

Please send me prices on the following:
Circle size of unit desired:
⅛" 3/16" ¼" 5/16"
Circle category for type of units needed:
(Check two if both apply)
A B C D
I want _____ (number) units:
Name_____
Position_____
Company_____
Street_____
City_____ State_____

Circle 516 on page 19

a new barrier where air gets so hot it loses its identity as air. Perhaps we may not even be able to transmit radio or radar signals through this layer of air that would surround an airplane in flight. So far, temperatures in this area—above 6000 F—have only been exceeded by man in shock tube experiments, the manufacture of synthetic diamonds and nuclear detonations.

"If heat did not remove itself from metal through radiation to space, obviously the contemplation of flight at these speeds would stagger the imagination. While it presents the engineer with a great many problems it does not appear impossible."



BUS OF THE FUTURE may look like this artist's version as early as 1966. According to Greyhound Lines, future models will feature passenger television sets, a raised deck, a special tinted roof, men's and women's lavatories, an observation dome, special baggage compartments, fog-piercing headlights, rear view television for the driver, and an airplane-like ramp at the rear.

Meetings

AND EXPOSITIONS

Jan. 14-16—

Third National Symposium on Reliability and Quality Control in Electronics to be held at the Hotel Statler, Washington, D. C. Sponsors are Institute of Radio Engineers, American Society for Quality Control, American Institute of Electrical Engineers and Radio-Electronic-Television Manufacturers Association. Further data are available from Mr. R. G. Murrell, Melpar Inc., Falls Church, Va.

Jan. 14-18—

Society of Automotive Engineers Inc. Annual Meeting to be held at the Sheraton-Cadillac and Statler Hotels, Detroit. Further information can be obtained from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Jan. 16-18—

Society of Plastics Engineers Inc. Thirteenth Annual National Technical Conference to be held at the Hotel Sheraton-Jefferson, St. Louis. Further information can be obtained from society headquarters, 34 E. Putnam Ave., Greenwich, Conn.

Jan. 21-25—

American Institute of Electrical Engineers. Winter General Meeting to be held at the Hotel Statler, New York. Further information is available from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

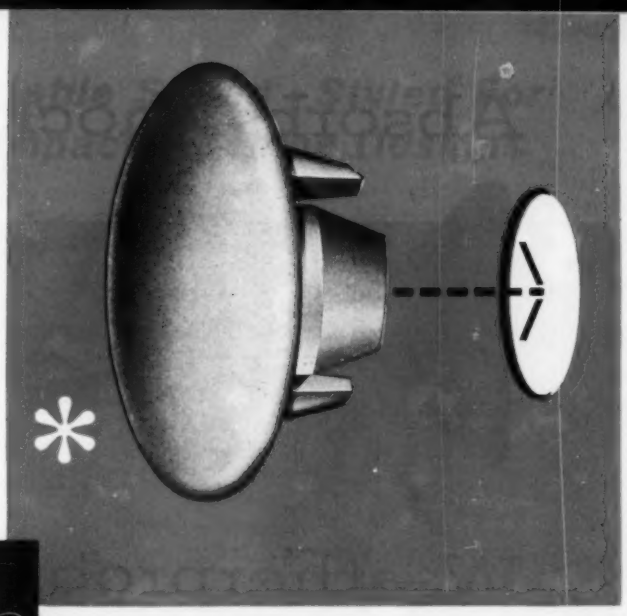
Jan. 28-31—

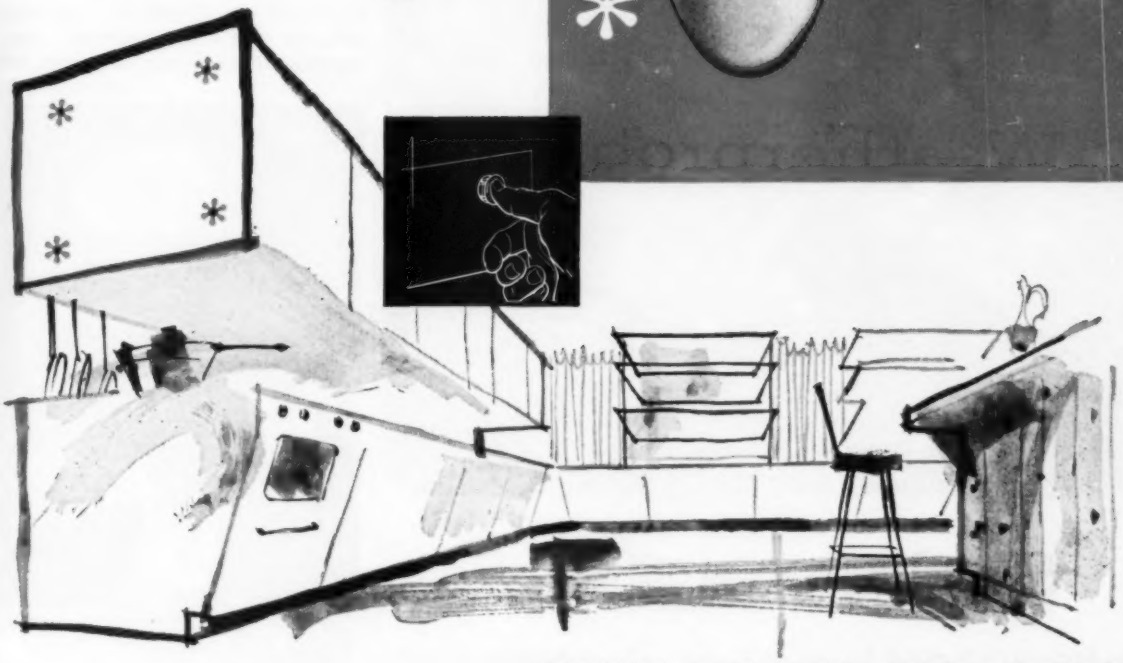
Plant Maintenance and Engineering Show to be held at the Cleveland Public Auditorium. Further information can be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

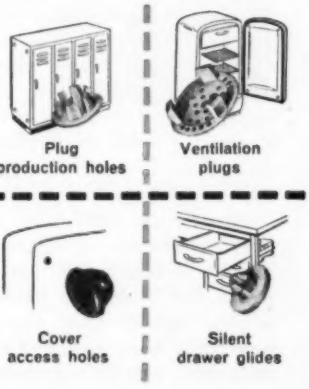
Good looks count

...and you can count on improved product appearance with

Plasti-Plugs®







Metal kitchen cabinets with unsightly production holes showing? Not if Fastex Plasti-Plugs (one piece, self-retaining hole plugs) are used! Snapping-in with a light touch of the finger, Plasti-Plugs are available in 45 standard sizes, in colors to match every product. Low in cost to buy and apply, Plasti-Plugs do double duty too—can be used for dust protection, friction glides and as replaceable plugs. Special moisture-sealing plugs may also be had. Made of polystyrene, nylon or vinyl, they're non-corrosive, always good-looking.

Trade Mark

FASTEX

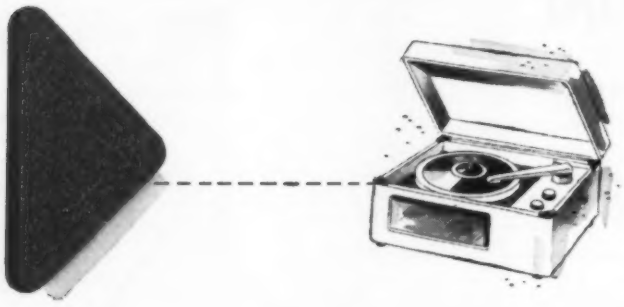
195 Algonquin Road, Des Plaines, Illinois
In Canada: Canada Illinois Tools Limited, Toronto, Ontario

Write for free catalog.
45 standard sizes
listed . . . tells how easily you can "snap in" Plasti-Plugs by Fastex.

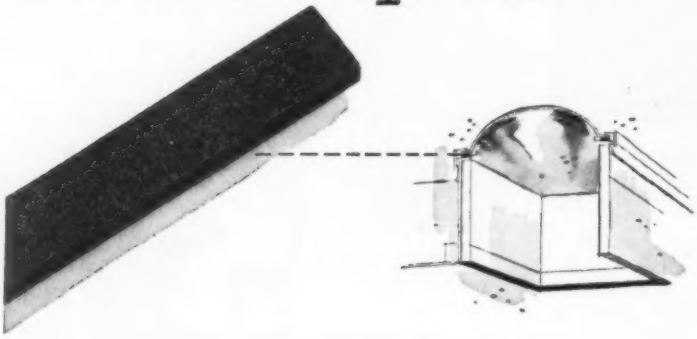
FASTEX
SHAKEPROOF
DIVISIONS OF ILLINOIS TOOL WORKS

Circle 517 on page 19

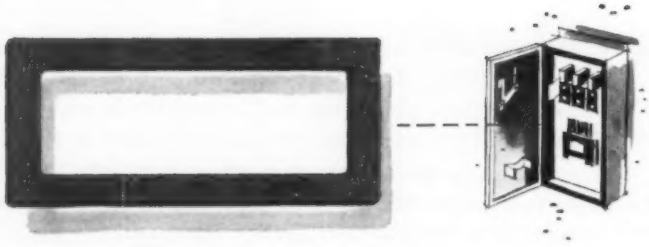
Absorbs shocks



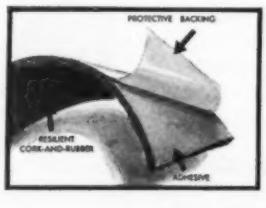
Weatherproofs



Seals



Armstrong DK-153 is a resilient cork-and-sponged-rubber composition backed with pressure-sensitive adhesive. It is a versatile material being used in hundreds of different ways in industry . . . as a shock absorber for record player lids, to keep air and rain from seeping in around skylights and ceiling domes, to seal dust and lint out of motor control boxes. You can get DK-153 in die-cut shapes, rolls, strips or sheets, and in 1/32", 1/16", 3/32", and 1/8" thicknesses. In any form, DK-153 is easy to apply; just peel off its protective covering and press into place. For samples, write Armstrong Cork Company, Industrial Division, 7312 Dean Street, Lancaster, Pennsylvania.



Armstrong DK-153

. . . used wherever performance counts

MEN

OF MACHINES

Announcement of the appointment of **R. J. Lindsey** to vice president in charge of engineering has been made by the Hydraulic Press Mfg. Co., Mt. Gilead, O. He was director of engineering. Mr. Lindsey joined the company in

R. J. Lindsey

1940 and subsequently served as assistant chief engineer and chief design engineer. From 1950 to 1955 he was chief engineer of Elmes Engineering Div. of American Steel Foundries. He then returned to H-P-M as director of engineering.

Francis A. Noll has been appointed director of engineering by Amana Refrigeration Inc., Amana, Iowa. Mr. Noll, who joined Amana a year ago as chief cabinet engineer, has been engaged in household refrigeration engineering work for nine years.

Jesse Stitzer has been appointed chief engineer of the Beta Electric Div. of Sorenson & Co., Inc., New York. Mr. Stitzer joined the division in 1950 in the test laboratory, then moved to the design division. He has served as a project engineer for the last three years. Mr. Stitzer replaces **Dr. Victor Wouk,**

who has been made general manager and engineering director.

Thomas F. Marlow has been appointed vice president in charge of engineering by the Standard Tube Co., Detroit.

A controls division has been established by Tipp Mfg. Co., Tipp City, O., for the purpose of producing a diversified line of packaged industrial controls. **R. A. Moenich** was named chief engineer of the division.

Mixing Equipment Co. Inc., Rochester, N. Y., has promoted **Richard D. Boutros** to vice president and director of engineering. He joined the company's engineer-

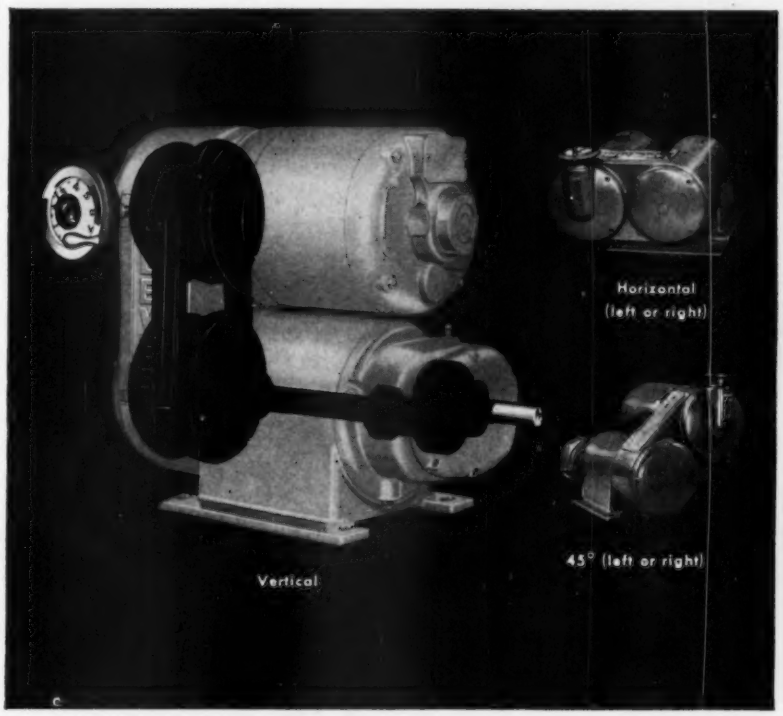
Richard D. Boutros

ing staff in 1946 and has been chief engineer since 1949.

Milton Dykman succeeds Mr. Boutros as chief engineer. Mr. Dykman also joined the firm in 1946; he has been assistant chief engineer since 1951. **Howard C. Shufelt** was named assistant to the chief engineer. He has been with the company since February 1955.

Joseph A. Despres has been appointed administrative assistant to the vice president for engineering at Ford Instrument Co., Long Island City, N. Y. Mr. Despres was associated with Bernard Rice's Sons Inc. for 20 years; for 13

Variable Speed—Styled For Compact Machine Designs

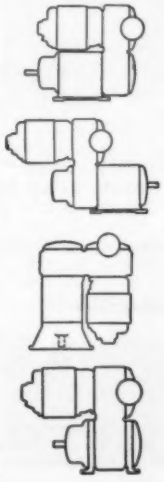


REEVES

FRACTIONAL *Vari-Speed* MOTODRIVE

WHERE DO YOU NEED THE OUTPUT SHAFT?

Motor side, control side, or vertical down



▶ REEVES fractional hp. Motodrive is a complete power package, engineered in over 100 assemblies to fit wherever your design calls for variable speed.

Choose from vertical, 45° or horizontal models in ¼ to 1 hp. . . . get stepless accurate speeds—within a 2:1 to 10:1 range—from as low as 3 rpm to a maximum of 4660 rpm.

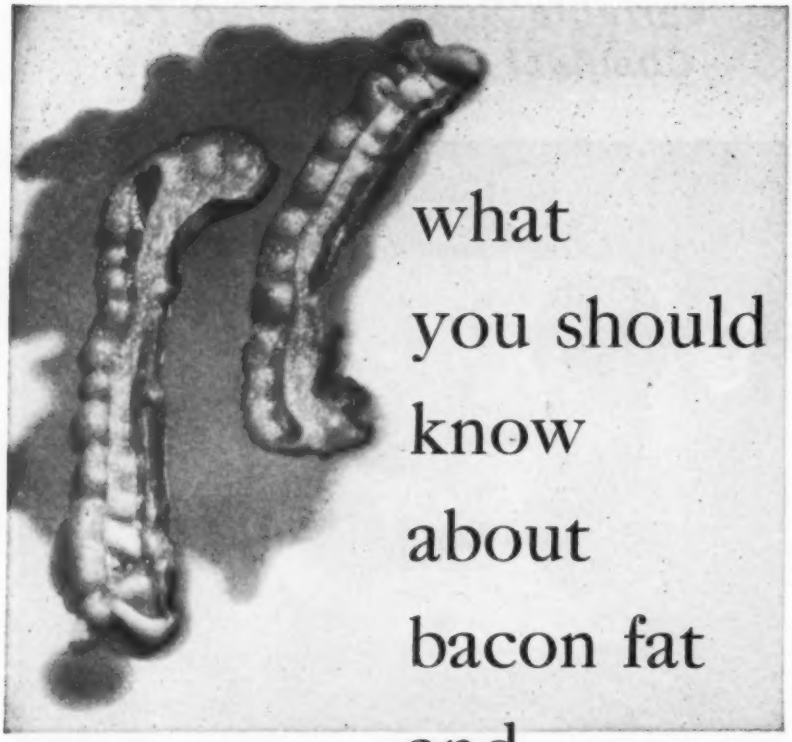
Available in standard, weather resistant, totally enclosed or splash-proof enclosures; full range of manual or automatic controls.

REEVES Motodrive—the *right* speed for *every* need . . . in *any* place.

Write Dept. H23b-M543 for ratings and dimensions.

REEVES PULLEY COMPANY
Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.
Columbus, Indiana

Circle 519 on page 19



what you should know about bacon fat and Albanene

Here's the buying information you should have to get the *best* value when you buy tracing paper.

1. **The usual way** of "transparentizing" tracing papers is with waxes or mineral oils—much the way bacon fat makes a paper towel transparent. Eventually, these oily fluids "leak" out—leaving the paper opaque and useless for reproductions.

   Result: Valuable drawings on ordinary tracing papers eventually become yellow or brittle—lose their reproduction qualities. And, these days, replacements often cost twice as much as the originals.

2. **The K & E way**—Albanene tracing paper is made transparent with an inert synthetic resin which is chemically stable . . . can't leak out—ever!

   Result: Albanene stays transparent . . . stays strong . . . protects every nickel you invest in time and talent working on it.

   Important: During manufacture, constant testing *guarantees* uniformity as well as pencil taking and erasing qualities. The very qualities that have made Albanene—America's best selling tracing paper.

Try Albanene Today . . . it's available in 3 weights and in rolls, sheets or pads. Try it now . . . it's the best value you can buy!

89 YEARS OF LEADERSHIP

In equipment and materials for drafting, surveying, reproduction and optical tooling . . . in slide rules and measuring tapes.

KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J. • Detroit • Chicago • St. Louis • Dallas • San Francisco • Los Angeles
Seattle • Montreal

Men of Machines

years he was president and chief engineer. He served for four years as administrative assistant to the director of the engineering and production division of Airborne Instruments Laboratory Inc.

Earl L. Steele recently was named chief development engineer of the Device Development Dept. in the Semiconductor Products Div. of Motorola Inc., Chicago. Dr. Steele's headquarters will be in Phoenix, Ariz.

Charles E. Rees Jr. was recently named assistant to the president, engineering, by Gladden Products Corp., Glendale, Calif. He will be in charge of all special engineering

Charles E. Rees Jr.

projects for the various divisions of the corporation. He will also serve in an advisory capacity for current engineering and manufacturing projects. Mr. Rees joined Gladden in 1951 as chief engineer.

Hyster Co., Portland, Ore., recently announced several changes in its engineering organization. **Robert C. Shoemaker,** supervising engineer of Construction Machinery for 12 years has been promoted to the position of supervising engineer, patents and product analysis. **T. Richard Hazel,** supervising engineer of the Tractor Equipment Div. for three years, has now been assigned the added responsibilities of supervising the Construction

Machinery design section. **Ronald A. Johnson,** supervising engineer in charge of the Standards Div., has now been assigned the I.B.M. engineering and catalog files.

Everett E. Christensen has been appointed assistant flight test division engineer for Lockheed's Missile Systems division, Van Nuys, Calif. For the last two and a half years Mr. Christensen has been base manager of the missile division's flight test facilities at Holloman Air Development Center, Alamogordo, N. M.

Rod Koutnik recently joined the Automatic Controls Div. of Clary Corp., San Gabriel, Calif.

S. Sydney Minault has been appointed vice president of National Research Corp., Cambridge, Mass. He joined this organization in 1953 and has served as general manager of the equipment division for the past two years. He has been associated with Sperry Gyroscope Co., the Ansco Div. of General Aniline & Film Corp. and Tracerlab Inc.

Leonard L. Johnson has been promoted to senior research engineer at Armour Research Foundation of Illinois Institute of Technology, Chicago.

Appointment of **Allan W. Jayne** as director of research has been announced by the Electronics Div. of the Gabriel Co., Needham Heights, Mass.

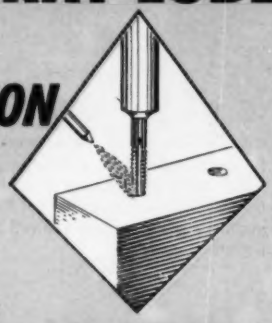
William Rainey has been appointed manager of new product development for W-S Fittings Div., H. K. Porter Co. Inc., Roselle, N. J. Mr. Rainey was previously an air conditioning engineer and contractor. He had also been associated with Orr and Sembower Co. of Pennsylvania and American Chain and Cable Co.

Appointment of **Clarence G. Bauer** as manager of quality control has been made by the Stamping Div. of Chrysler Corp., Detroit. He has been associated with the company since 1931.

Norgren SPRAY-LUBE

INCREASES PRODUCTION from MACHINE TOOLS

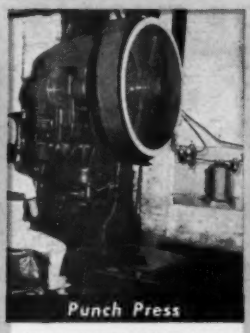
- Increases Tool Life
- Improves Quality of Work
- Reduces Maintenance Costs



Metal Cutting Saw

CUTS FASTER... DOESN'T OVERHEAT

Oliver Sawing Machine cuts 4" to 6" slabs of non-ferrous metals. By changing to SPRAY-LUBE: (1) Fusion of chips to saw teeth ended. (2) No galling—surfaces now resemble machined finish. (3) Saw feed faster—cuts 6" aluminum slabs at 5 fpm.



Punch Press

OUTPUT INCREASED 15% DIE LIFE INCREASED 100%

Formerly lubricated by hand swabbing every 6 cycles of press, splashing on machine, floor and operator. Now, SPRAY-LUBE automatically lubricates die and blank every cycle, increasing die life 100% and output 15%. Lubricant cost cut in half.

Tapping Machine

30% MORE OUTPUT

SPRAY-LUBE replaced flood system on tapping machine at the Square D Company, eliminating excess of lubricant and ending time lost for cleaning parts. Splashing lubricant on operator and floor also ended. Production increased 30%.

Gear Hobbers

$250 A YEAR LUBRICANT SAVING PER MACHINE

Cullman Wheel Co. replaced splash coolant systems on gear hobbers with SPRAY-LUBE. Results: (1) Tool life increased. (2) Tool grinding time reduced. (3) Working conditions cleaner, safer. (4) $250 a year per machine saved in lubricant costs.

Turret Lathe

OUTPUT DOUBLED

SPRAY-LUBE on lathe at O.K. Rubber, Inc. has: (1) Increased surface cutting speed from 45 to 75 rpm, nearly doubling output of machine. (2) Ended welding of chips to tool. (3) Increased depth of cut. (4) Improved quality of work.

Chain Drive

OVER TWO TIMES LONGER CHAIN LIFE

At Wagner Electric in St. Louis, SPRAY-LUBE automatically lubricates chain drive on degreasing machine. Chain now runs smoothly and quietly. Lubricant, removed by the hot cleaning solution, is now constantly replaced, doubling chain life.

For complete information about Norgren SPRAY-LUBE, call your nearby Norgren Representative listed in your telephone directory—or WRITE THE FACTORY for Bulletin 537.

C.A. Norgren CO.

C. A. NORGREN CO. 3442 So Elati St., Englewood, Colorado

Reynolds can paint entire parts a solid color, mask and paint or do paint filling in combination with mechanical finishing to supply practically any desired texture or highlighting effect.

Part of a battery of new high speed buffing equipment available at Reynolds. Scratch-brushing, satin finishing, highlighting, embossing and other mechanical finishes are also available.

Alodine system at Reynolds is adaptable to immersion, spray or brush type finishing. Etching, brightening and other chemical finish treatments are also available at Reynolds.

for greater design freedom and finer "finished" aluminum products ... use the new, vastly expanded

REYNOLDS

FINISHING FACILITIES

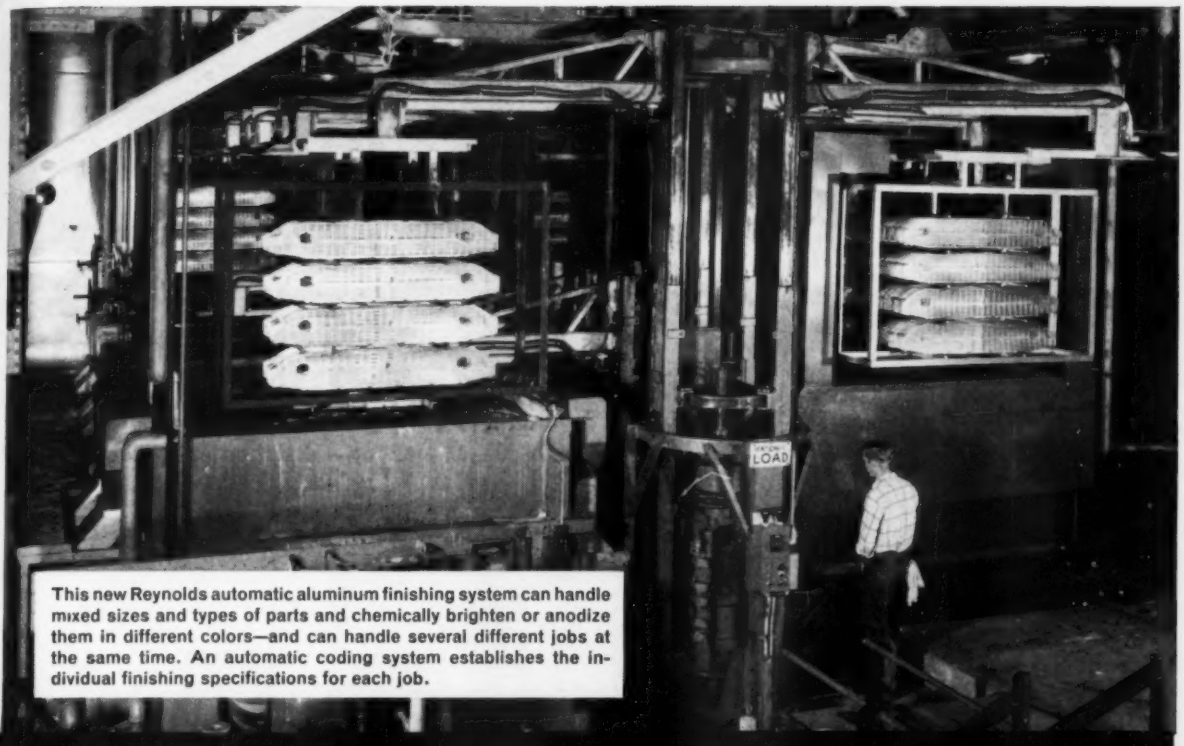
For the magic touch of gleaming clear and color anodized finishes—and for many types of mechanical, chemical and paint film finishes—you can depend on finishes from Reynolds to add sales appeal and value to the aluminum products you design.

Reynolds multi-million dollar investment in finishing equipment—some of this equipment illustrated on these pages—assures you the finest aluminum finishing facilities available anywhere. These recently expanded facilities permit new and greater flexibility in your design thinking. And these facilities are backed by Reynolds years of technical experience with practically every finishing process and technique applicable to aluminum plus Reynolds quality control from mine to finished part.

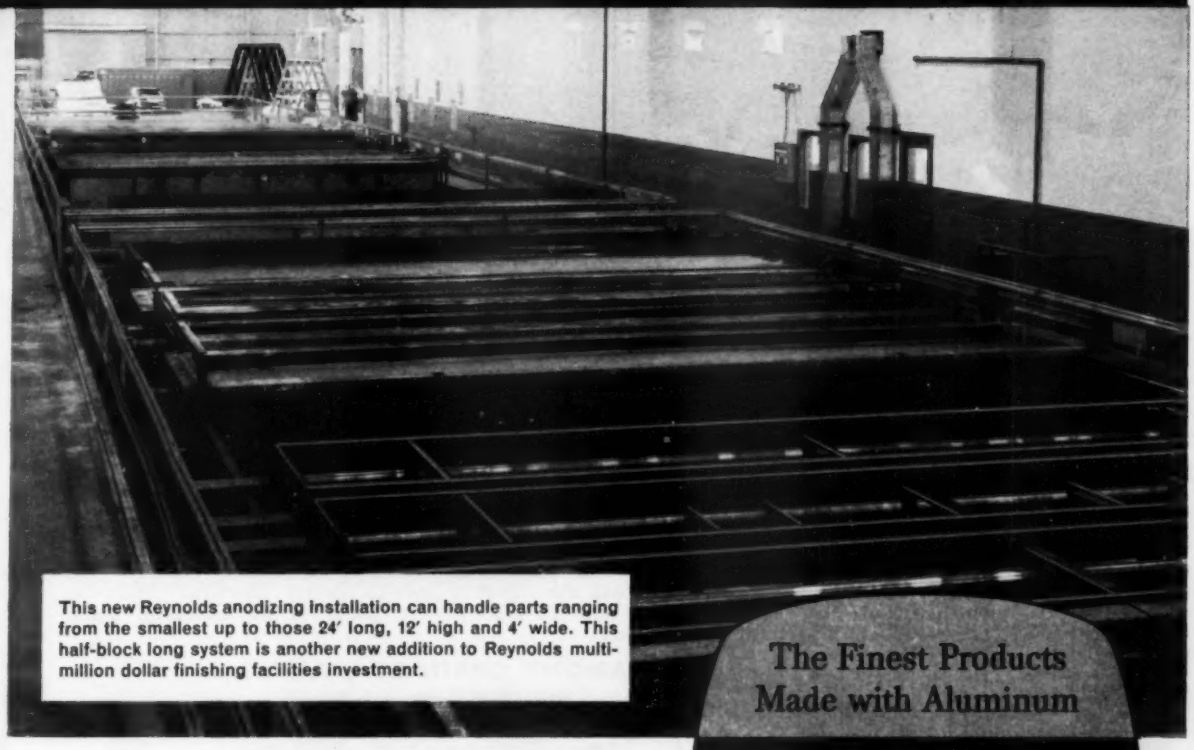
For full details on the finishing and fabricating facilities available, call the Reynolds Office listed under "Aluminum" in your classified telephone directory or write *Reynolds Aluminum Fabricating Service, 2061 South Ninth Street, Louisville 1, Ky.*

See "CIRCUS BOY", Reynolds new dramatic series, Sundays on NBC-TV

REYNOLDS ALUMINUM FABRICATING SERVICE



This new Reynolds automatic aluminum finishing system can handle mixed sizes and types of parts and chemically brighten or anodize them in different colors—and can handle several different jobs at the same time. An automatic coding system establishes the individual finishing specifications for each job.



This new Reynolds anodizing installation can handle parts ranging from the smallest up to those 24′ long, 12′ high and 4′ wide. This half-block long system is another new addition to Reynolds multi-million dollar finishing facilities investment.

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

BLANKING · BRAZING · DRAWING · EMBOSSING

FINISHING · FORMING · RIVETING

ROLL SHAPING · TUBE BENDING · WELDING

Circle 522 on page 19

Pre-stressed
Diamond Roller Chains pass highest lifting standards for Clark Equipment

PRE-STRESSED
Pre-stressing by Diamond brings pin-bushing seating into stabilized relationship prior to installation.

SHOT-PEENING
Link plates, rollers and other parts of Diamond Chains have been shot-peened since 1944 to increase fatigue resistance.

UNIFORM CONSTRUCTION
Specialized heat treating, manufacturing facilities and testing procedures guarantee uniform highest quality in every Diamond Chain.

Trade ◇® Mark

On leading makes of materials handling equipment, such as the Clarklift 40 illustrated, Diamond Roller Chain is first choice for lifting as well as for other power transmission requirements.

The reasons are clear. Diamond Roller Chains give more economical performance over a longer service life. Their extra high uniform quality means dependable, safe operation. Pre-stressing and other special manufacturing techniques increase Diamond Chains' ability to take rough treatment and minimize maintenance at the same time.

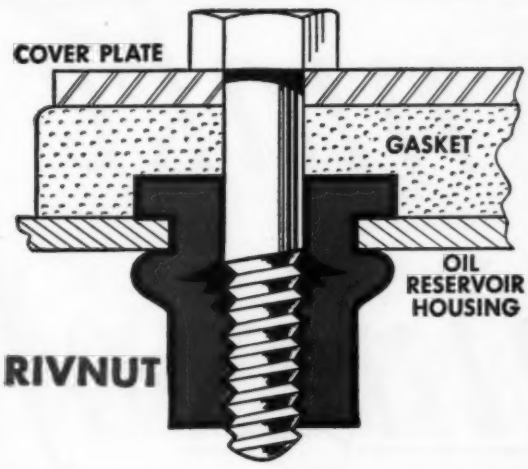
Your records will show that it pays to specify Diamond Chain for new equipment and for replacement. Look for the Diamond trade mark on the links.

DIAMOND CHAIN COMPANY, Inc.
Where High Quality is Traditional
Dept. 435, 402 Kentucky Ave., Indianapolis 7, Indiana
Offices and Distributors in All Principal Cities

DIAMOND ROLLER CHAINS

B.F.Goodrich RIVNUTS

save time, cut costs by eliminating welding, tapping, cleaning



OLD WAY

1 Weld 4 nut plates to inside of housing
2 Drill
3 Tap
4 Clean
5 Attach cover with bolts

WITH RIVNUTS

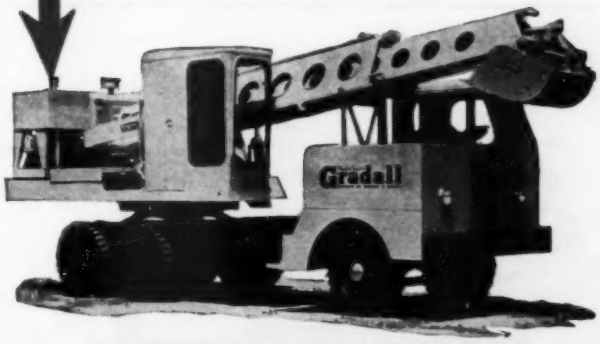
1 Punch holes in housing
2 Insert Rivnuts and upset
3 Attach cover with bolts

B. F. GOODRICH RIVNUTS cut costs and speed assembly by providing a firm, accurate nutplate in one operation!

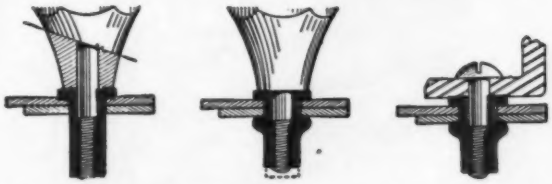
This fastening job on Warner & Swasey's Multi-Purpose Gradall used to take five operations. Oil reservoir housings had to be detoured from the assembly line to weld four nutplates on the inside. Then they were drilled, tapped and cleaned before the cover could be attached. By switching to Rivnuts, welding, tapping and cleaning were eliminated.

Now one worker installs Rivnuts from one side in seconds. Assembly flow is straightline. Fastening time is cut in half.

B. F. Goodrich Rivnuts have speeded up thousands of fastening jobs and eliminated costly steps. They can do the same for you. Get more information or engineering help by writing: *Rivnut Sales, B. F. Goodrich Tire & Equipment Company, a Division of The B. F. Goodrich Company, Akron, Ohio.*



HOW RIVNUTS PROVIDE AT LEAST 6 CLEAN THREADS IN ONE SIMPLE OPERATION:



1 Rivnut is threaded onto pull-up stud of heading tool, then inserted.

2 Tool lever operates pull-up stud forming a bulge in the Rivnut shank.

3 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

RIVNUT

THE ONLY ONE-PIECE BLIND RIVET WITH THREADS

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten WITH and TO. Explains construction, simplicity of installation. Get your free copy by writing to: The B. F. Goodrich Co., Dept. MD126, Akron, Ohio.

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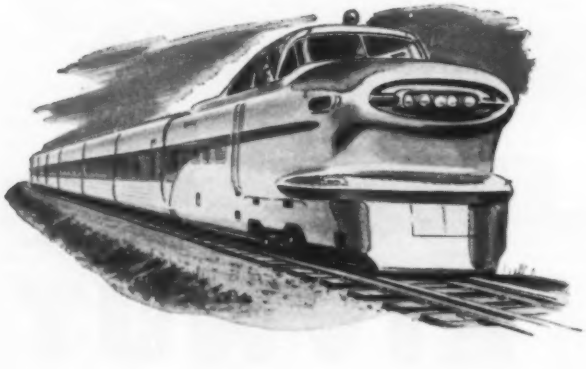
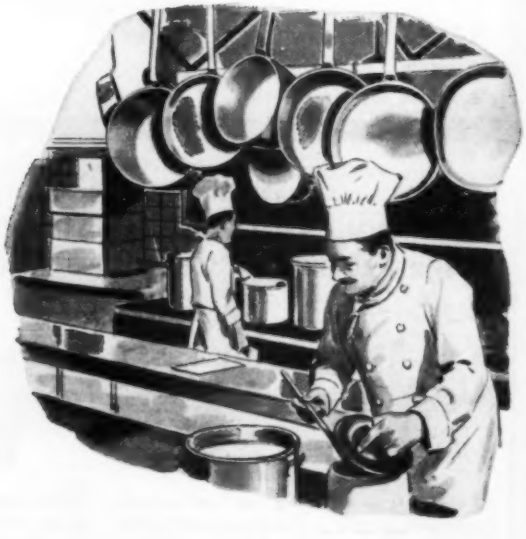
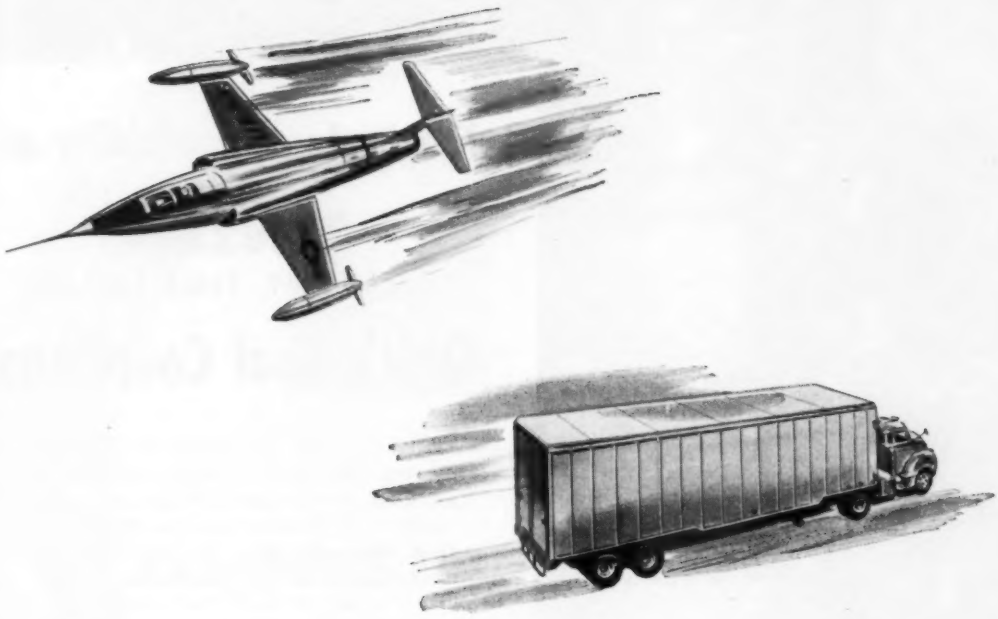
Now... You can make more things of







Stainless Steel

The new "200" Series Stainless Steels successfully ease nickel shortage!

With the new low-nickel "200" Series Stainless Steels, producers can greatly expand their output of Chrome-Nickel stainless from existing nickel supplies. These steels provide practical, workable grades of stainless that can be applied to a wide variety of uses.

Made of Chromium-Nickel-Manganese—the "200" Series steels are helping to meet constantly growing needs in transportation, building, manufacturing and many other fields. They're becoming increasingly popular in kitchen utensils, appliances, truck bodies, trains, automobile trim, and scores of products for industrial, home and business use. For further information, see your stainless steel supplier, or write Electromet—leading producer of more than 100 alloys, including chromium and manganese, for the steel and non-ferrous metal industries.

ELECTRO METALLURGICAL COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York 17, N. Y.

The term "Electromet" is a registered trade-mark of Union Carbide and Carbon Corporation

Electromet

Metals do more all the time... Thanks to Alloys

Offices: BIRMINGHAM • CHICAGO • CLEVELAND • DETROIT • LOS ANGELES • HOUSTON • PHILIPSBURG, N. J. • PITTSBURGH • SAN FRANCISCO

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Now... Local Availability on

Titeflex

Seal-Tight, Time-Saving

Quick-Seal Couplings

Titeflex Couplings are *leakproof* at *all* operating pressures—the higher the pressure the tighter the seal! Couple or uncouple in ONE second... without the aid of tools. Straight-through or single or double check-valve types. Allow free flow of *any* viscous material. Sizes from ¼" to 12" diameter. Made from a variety of metals and alloys to suit innumerable industrial applications.

Titeflex

Flexible Metal Hose

—the ideal "conveying mate" for Titeflex Couplings. Withstands high temperature and pressure stresses. Impervious to vibration and corrosive action.

Both these time-tested products are available for immediate shipment from distributors' stocks in most areas. Otherwise write, wire or telephone direct.

CALL YOUR LOCAL DISTRIBUTOR

Consult the yellow pages of your telephone directory

Your one source for both Hose and Couplings

Titeflex

TITEFLEX, INC., 508 HENDEE STREET, SPRINGFIELD 4, MASS.

Circle 526 on page 19

Tapered for positive suspension.
High radial sealing surface.
"Tongue and groove" for easy installation.
Clearance for radial motion.

KOPPERS HUHN CARBON RING

Reduces Steam Loss as much as 90%!

The unique design of Koppers Huhn Carbon Ring reduces steam loss far below the customary 1% loss of labyrinths and carbon garter spring rings. Huhn Carbon Ring keeps steam loss as low as ¼ of 1% . . . often as little as 1/10 of 1%. Using your own figures for steam costs, you can easily discover how much Koppers Huhn Carbon Rings can save you annually.

The design assures you continuous radial sealing . . . because a radial sealing surface is always forced against a chamber wall. Automatic suspension . . . even during shutdowns . . . prevents shaft contact, reduces wear, and prolongs life. The Huhn Carbon Ring operates with peak efficiency at highest shaft surface speeds and highest operating temperatures.

Koppers Huhn Carbon Ring replaces labyrinths and carbon garter spring rings in compressors, and steam and water turbines. Steam savings alone often pay within a year for the cost of replacement. Discover now how Huhn Carbon Rings reduce steam and fluid losses and minimize operating, maintenance and repair costs. Write: KOPPERS COMPANY, INC., *Piston Ring and Seal Dept.*, 2312 Hamburg St., Baltimore 3, Md.

Koppers Company, Inc.
Metal Products Division
Piston Ring and Seal Dept.

***Engineered* Products**
Sold with *Service*

KOPPERS®

MECHANICAL SHAFT SEALS

Circle 527 on page 19

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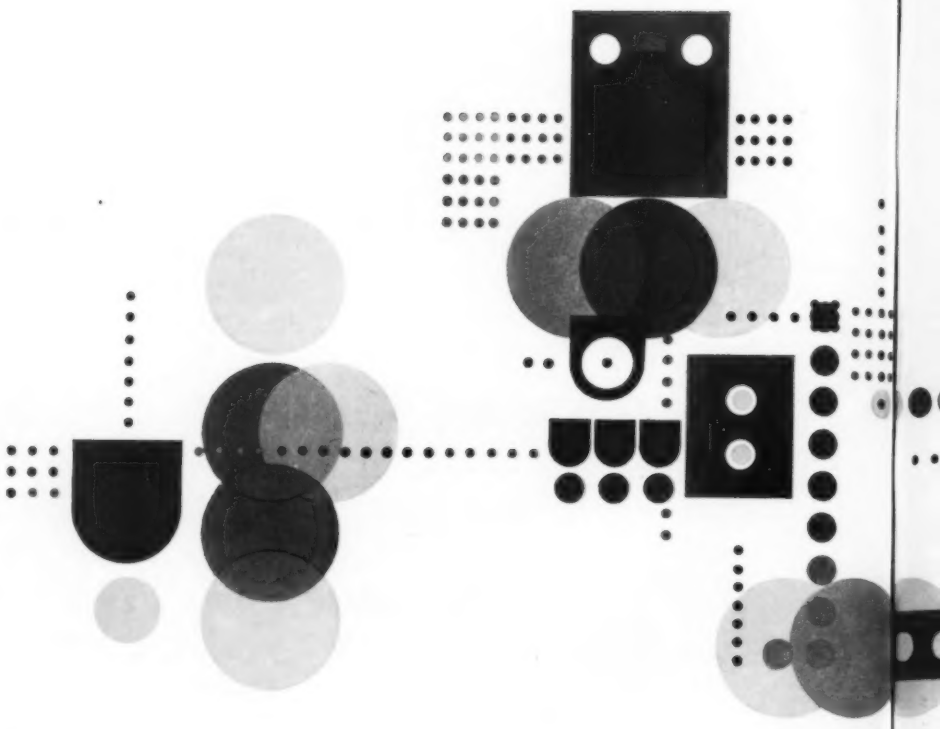
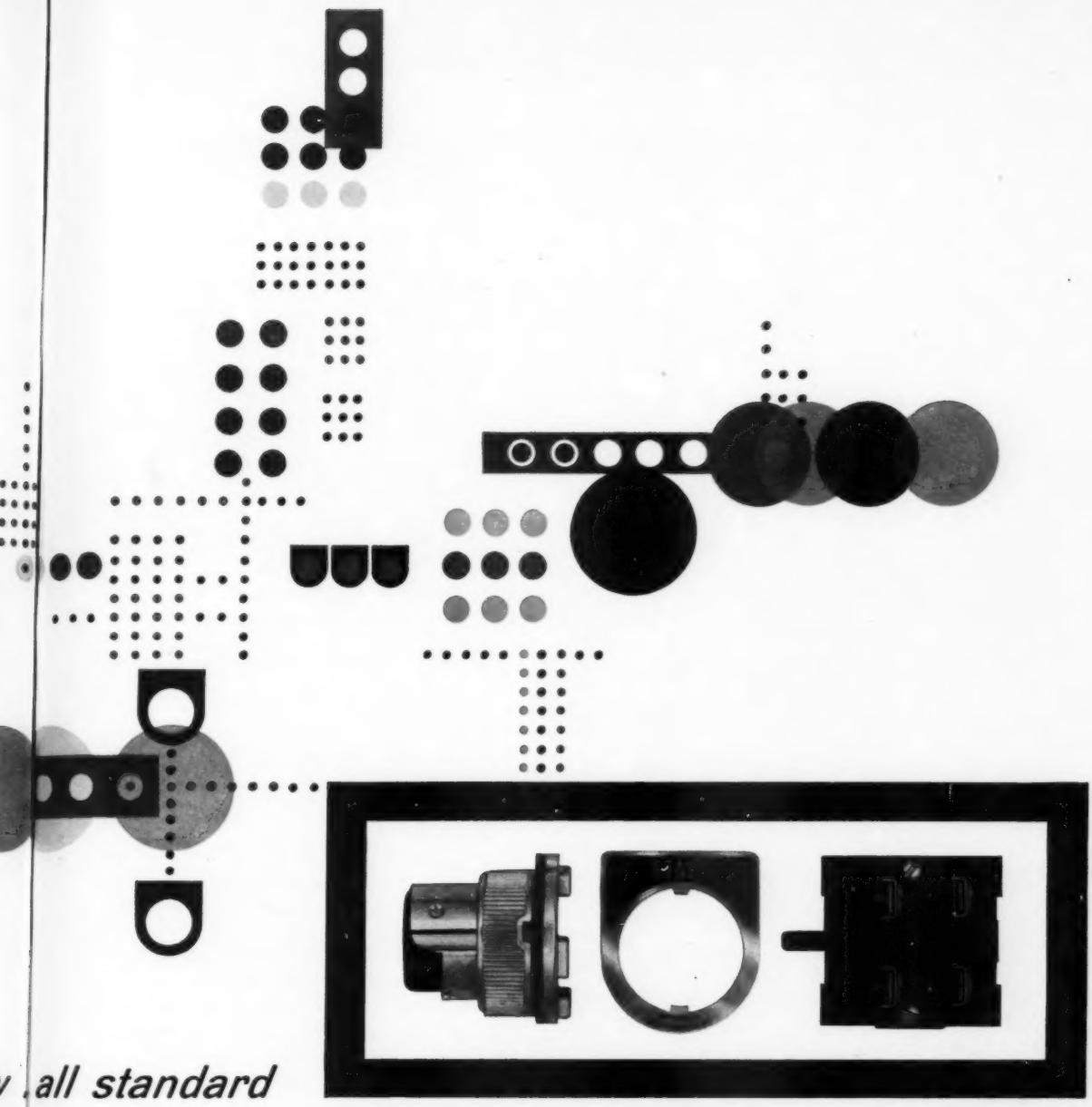


Pushbutton control arrangements almost to infinity .all



all standard

How'd you like a stock of 1,500,000 pushbutton controls on hand at all times for original equipment needs or for production purposes?
Sound prohibitive space-wise, or too expensive? Not at all. Just 38 Westinghouse components (shown above) do it because all parts are standardized and interchangeable. And always available from stock.
If you need controls for any application, write for the free 72-page *Pushbutton Guide*, B-6749. For control where moisture is a problem, write for free Booklet, B-7022, about Oil-Tite* controls. Write to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. Or call your Westinghouse Distributor.
*T. M. J-30248

YOU CAN BE SURE...IF IT'S

Westinghouse

Circle 528 on page 19

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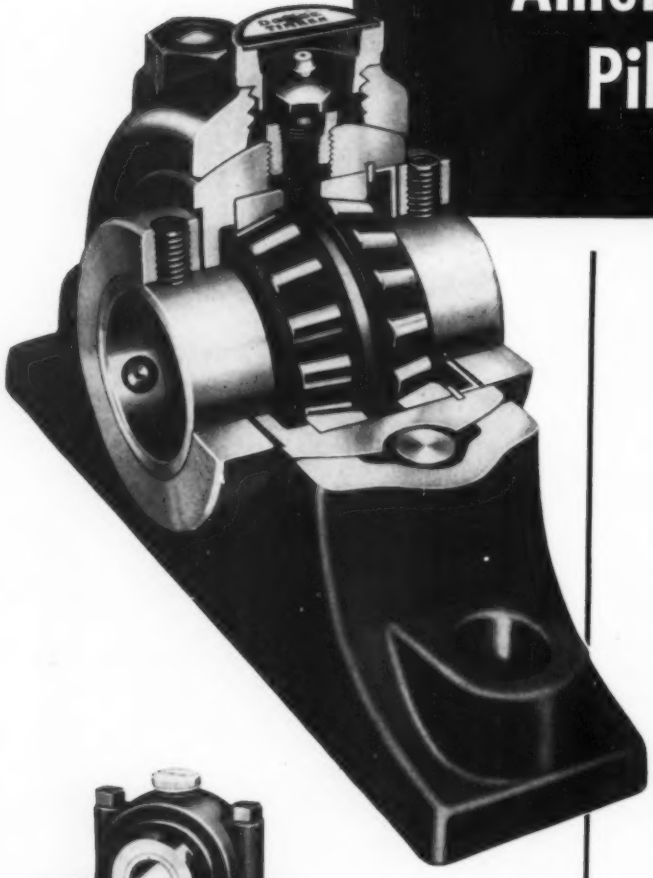
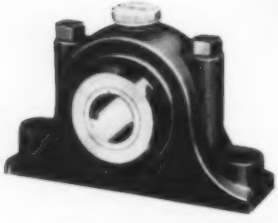
AVAILABLE IN FIVE TYPES
FOR ALL KINDS OF SERVICE

DODGE-TIMKEN
America's Quality Pillow Block





- COMPLETELY ASSEMBLED
- FACTORY ADJUSTED
- PRE-LUBRICATED

Call the Transmissioneer, your local Dodge Distributor. Factory-trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

DODGE-TIMKEN Bearings are adjusted, lubricated and sealed at the factory. Labrynth seals effectively retain the lubricant and prevent the entrance of dust and dirt. The inbuilt precision of Dodge-Timken Bearings is protected both on and off the shaft. They are delivered fully assembled, ready to mount.

Where service conditions are toughest Dodge-Timken Bearings prove their quality decisively. For superior performance, dependability and long life they have won their reputation throughout industry as America's quality pillow blocks.

To meet varying service requirements Dodge-Timken Pillow Blocks are available in five types—the type E . . Double Interlock (illustrated) . . Type C . . Special Duty . . . and All-Steel. Available in a range of shaft sizes from 1-3/16" to 10".

Call your Transmissioneer; or write for Bulletin A638 giving load ratings, dimensions and other data on Dodge-Timken Roller Bearings.

DODGE MANUFACTURING CORPORATION
3300 Union Street, Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

Circle 529 on page 19

only

CLEARPRINT Tracing Paper

does so many things so well!

For the perfect working surface, for ghost-free prints, for proven stability - Clearprint Technical Paper has no equal. Since its introduction in 1932, other paper makers have strived to duplicate Clearprint's quality. None has succeeded. Your drawings deserve this superior paper. Insist on genuine Clearprint, *watermarked* for your protection.

THERE'S A CLEARPRINT PAPER FOR EVERY JOB

Tracing Paper • "Papercloth"
Clearprint Charts
Federal Aid Sheets
"Fade-Out" Grid Paper

IN SHEETS, PADS and ROLLS

YOU BE THE JUDGE...

Make this simple

CLEARPRINT TEST

1. INVITES PENCIL AND PEN —

Try Clearprint's perfect working surface with a 2H pencil, then with a ruling pen. Lines are sharp and clean — no feathery edges.

2. NO GHOSTING —

Erase some of the lines. Redraw and erase several of them repeatedly. Crease the paper, too. Then hold it to the light, or make a reproduction. Seeing is believing!

3. NEVER CHANGES —

Sheets in use since 1932 prove Clearprint does not tear or become "dog-eared" in the files. Its strength, transparency and printing qualities remain unchanged after extended exposure to age, atmosphere, heat and light.

Make this test, too, on the paper you are now using. The difference will convince you.

CLEARPRINT®

TECHNICAL PAPER

THERE IS NO SUBSTITUTE
Demand Watermarked Clearprint

SEEING is BELIEVING!

Ask your dealer for samples, or send coupon

CLEARPRINT PAPER CO. MD
1482 - 67th St., Emeryville, Calif.

☐ Please send me Clearprint Paper samples, with prices, for the following uses: _____

_____

☐ Please have your representative call at my office.

Name _____

Firm _____

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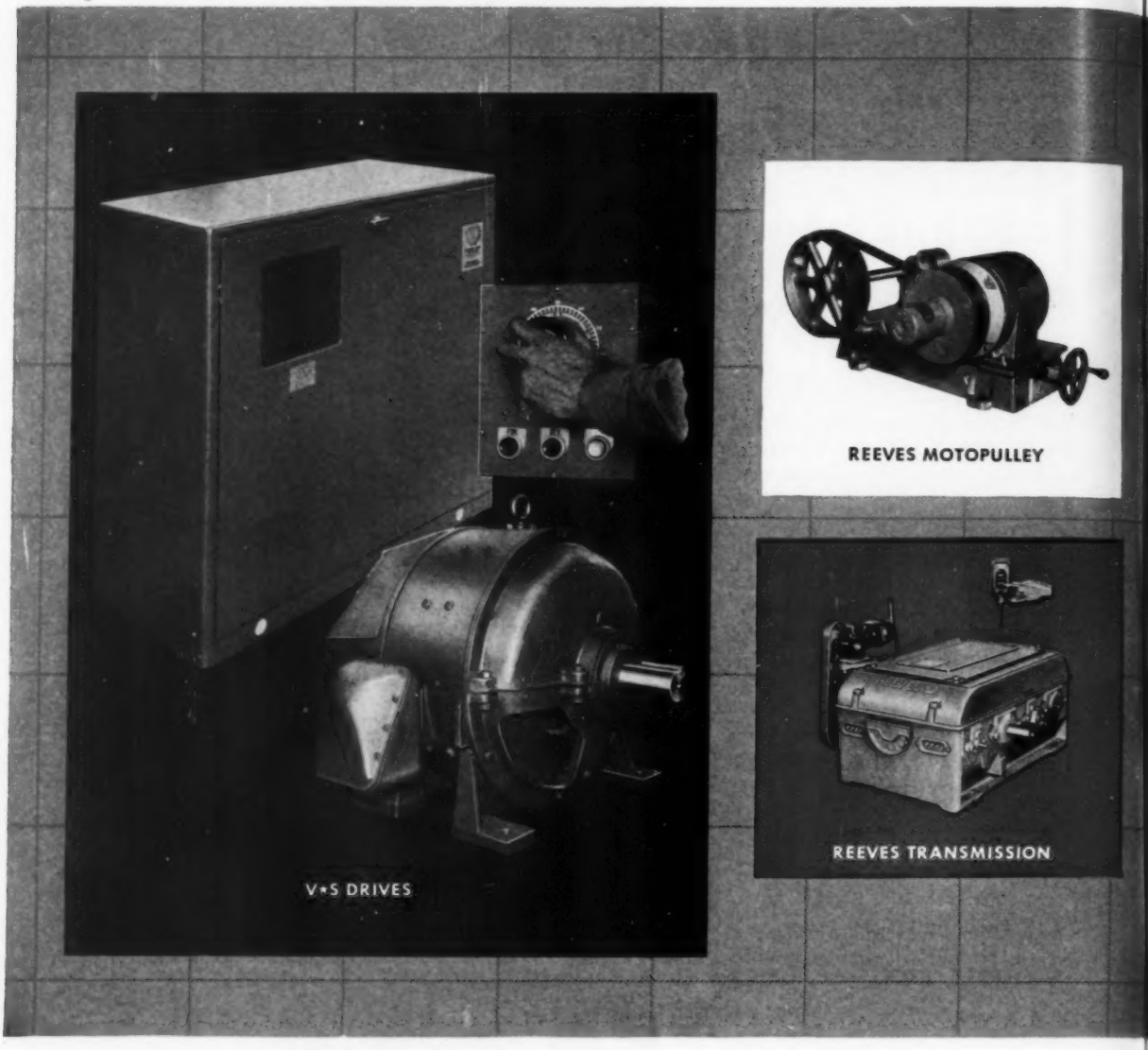


● WIDENING THE HORIZONS OF

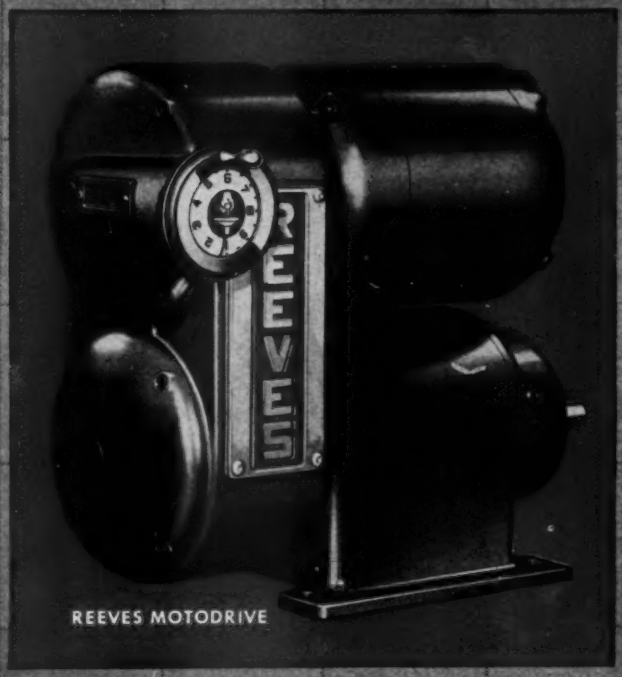
Automation is the key to greater production of more goods and services at lower cost. The Tools of Automation can be applied profitably in a countless number of individual industries.

Reliance can provide *you* with valuable engineering assistance which can help secure the advantages of automation.

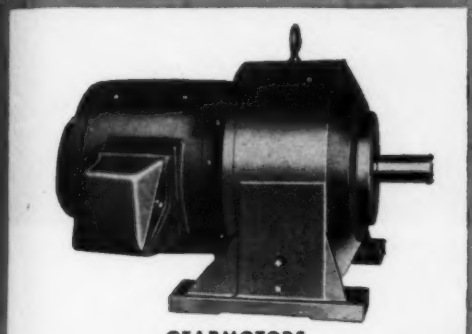
Our Tools of Automation consist of electric motors, variable-speed drives and controls.

RELIANCE

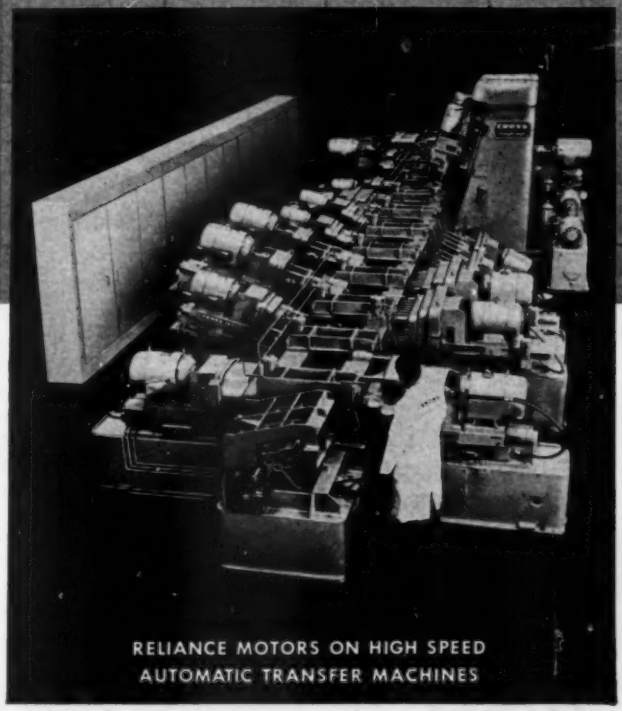
TOTALLY-PROTECTED MOTORS



REEVES MOTODRIVE



GEARMOTORS



RELIANCE MOTORS ON HIGH SPEED AUTOMATIC TRANSFER MACHINES

AUTOMATION

Application of these tools ranges from a single motor to multi-motor drives for highly complex production lines, where materials are processed into finished products in one continuous operation.

The world's largest manufacturer devoted exclusively to the production of quality motors and drives is ready to help you widen the horizons of automation in your plant.

Bulletin No. A-1555-B gives further details.

A-1519

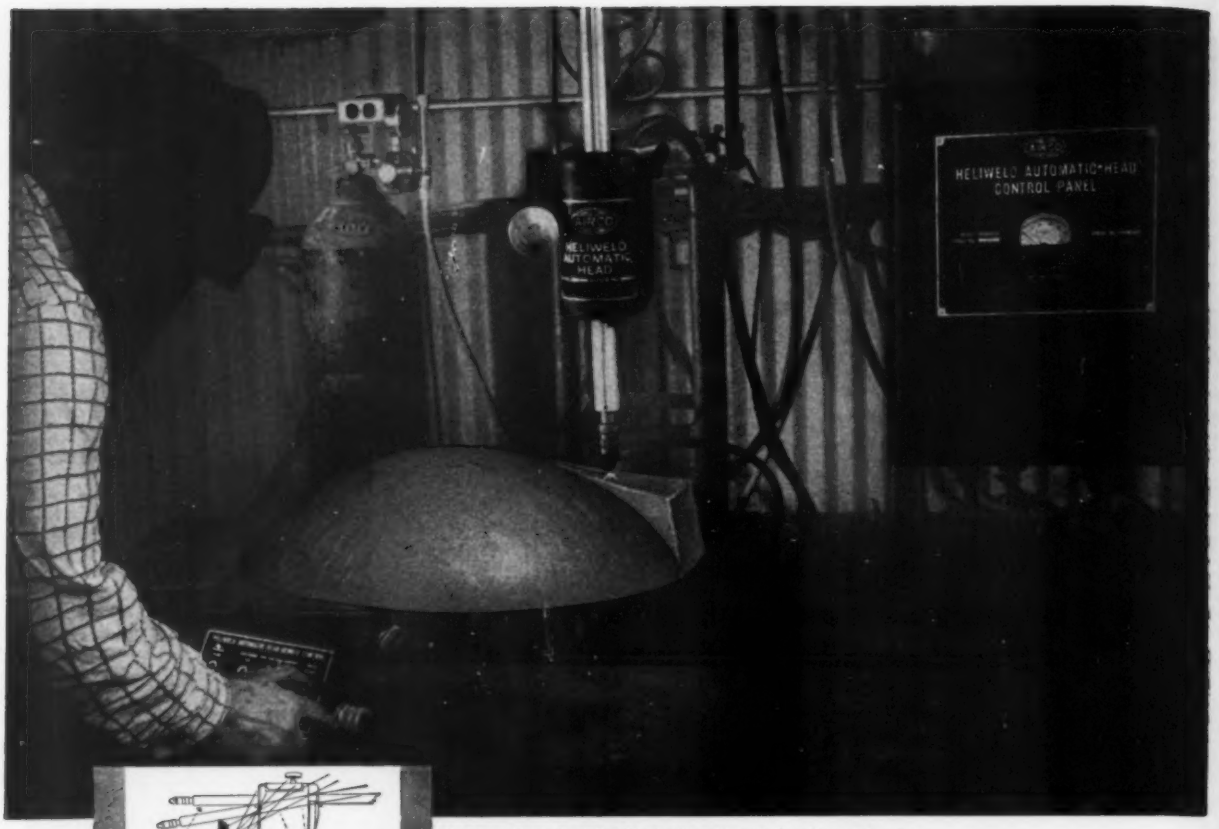
ELECTRIC AND ENGINEERING CO.

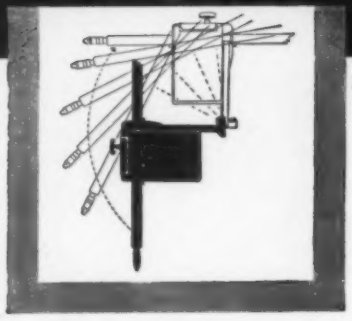
DEPT. 2812A CLEVELAND 10, OHIO

Canadian Division: Welland, Ontario • Reeves Division: Columbus, Indiana

Circle 531 on page 19

XUM





New Airco Model C Heliweld automatic head operates at all angles from horizontal to vertical.

Airco introduces New Automatic Heliweld Head for long-run production welding

The Model C Heliweld automatic head is specifically designed for long-run production on regular or irregular contours — aluminum tubing, motor stators, irregularly-shaped pressure vessels. Its prime advantage is that once the required arc length is set the head will automatically maintain this distance by moving the holder up or down to follow the contours of the work piece. Other benefits are:

- **Versatility** — unit provides good arc voltage control using either argon or helium shielding gases or mixture of both.
- **Adaptability** —the head can be operated at all angles from the horizontal to the vertical (normal) position. The maximum raise-lower distance of the electrode holder is a full 16".
- **Flexibility** — the assembly can be used for AC or DC welding, with or without filler wire. Electrode diameters range from .020 to ⅛".

The use of the new automatic head will be required where welds of consistent dimensions and quality are important and where good weld appearance is necessary or where welding specifications are very high for the electrical, aircraft, and refrigeration industries. Complete information covering the wide range of applications and detailed specification data is available. Write Airco at the first opportunity.

AT THE FRONTIERS OF welding PROGRESS YOU'LL FIND . . .

AIRCO

Offices in most principal cities

AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated, New York 17, N. Y.

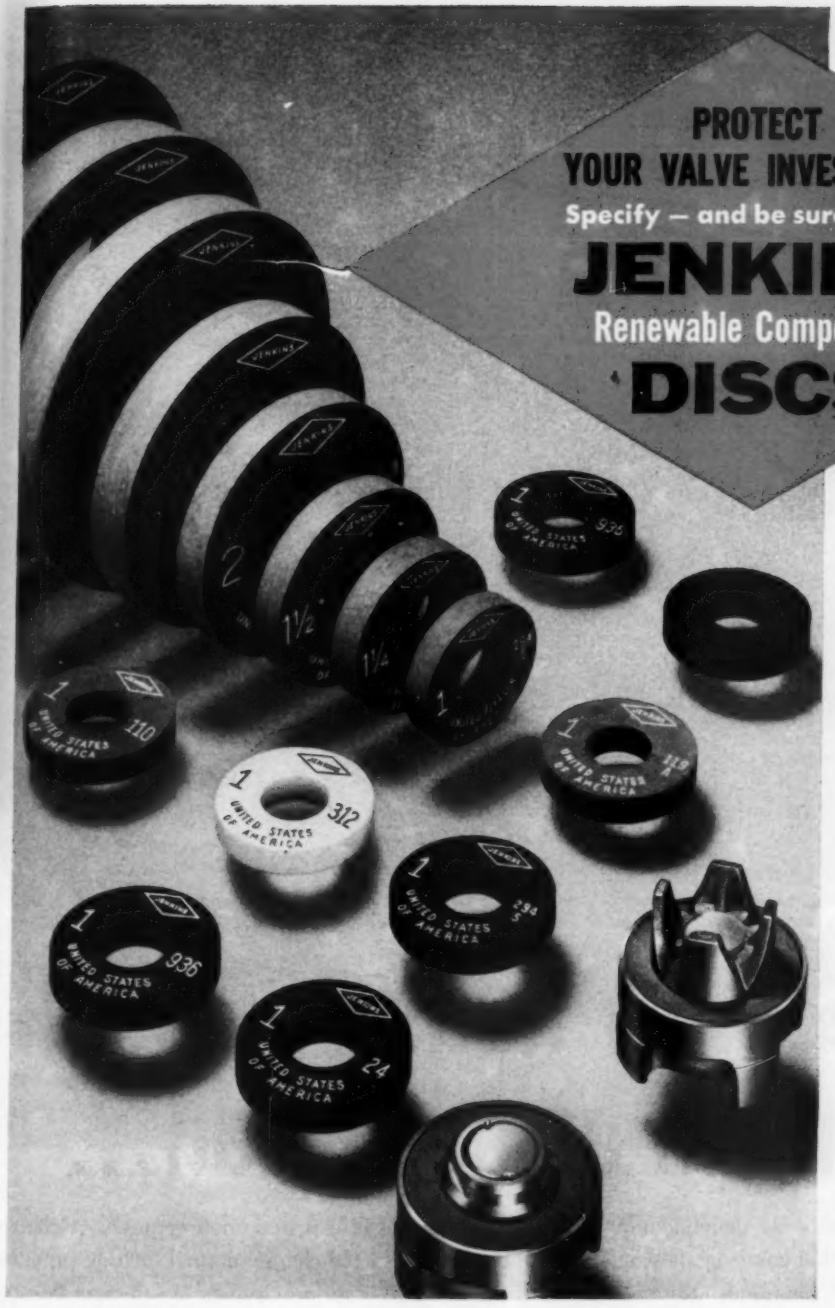
On the west coast — Air Reduction Pacific Company

Internationally — Airco Company International

In Cuba — Cuban Air Products Corporation

In Canada — Air Reduction Canada Limited

Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** — industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** — carbon dioxide, liquid-solid ("DRY-ICE") • **OHIO** — medical gases and hospital equipment • **NATIONAL CARBIDE** — pipeline acetylene and calcium carbide • **COLTON** — polyvinyl acetates, alcohols, and other synthetic resins.



LOOK FOR THE JENKINS DIAMOND

MADE BY THE ORIGINATORS OF RENEWABLE DISC VALVES

Jenkins Bros. has remained the leader in composition disc development and production since 1864, when the first renewable disc valve was introduced.

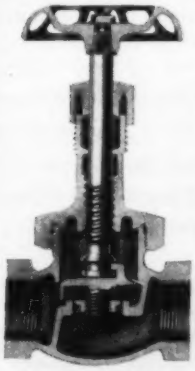
THE ONLY MANUFACTURER OF BOTH VALVES AND DISCS

Jenkins Bros. devotes continuous laboratory and field research to disc improvement through use of new compounds, and new production techniques.

NEW GUIDE FOR DISC SELECTION

Describes all Jenkins Discs, and their applications for steam, hot and cold water, air, gas, oil, gasoline . . . including the new TEFLON® DISC for lasting, dependable control of oxygen and other gases, solvents, acids, alkalies, and other chemicals,—and for liquid food and similar services.

Ask your Jenkins Valve Distributor for Disc Folder Form 203, or write: Jenkins Bros., 100 Park Ave., New York 17.



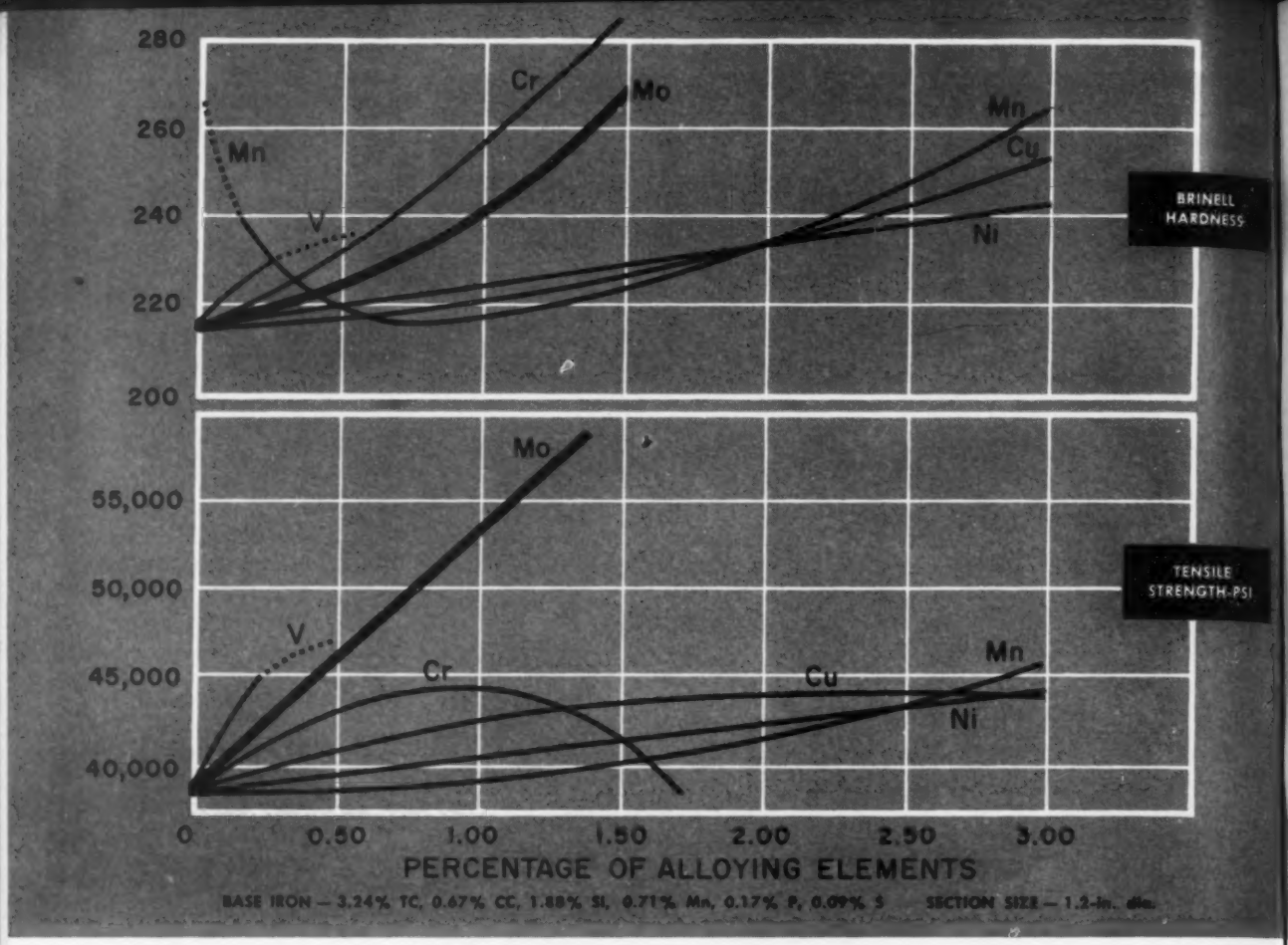
. . . for highest efficiency, use the time-proved combination . . . JENKINS DISCS in

JENKINS VALVES

TRADE JENKINS MARK
Jenkins Bros

Order from Your Local Jenkins Distributor

Circle 533 on page 19



Note how additions of moly, up to 1.5%, produce proportional improvements in strength. And, with moly, hardness increases much more slowly. It means higher strengths can be used with less danger of impaired machinability.

each ½% Moly adds 7000 psi to strength of cast iron...

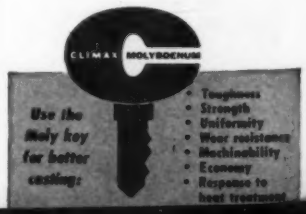
A little moly adds a lot of strength – for molybdenum increases strength more than any other common alloying element, with the exception of small vanadium additions. A rule of thumb is that fifty points of moly raise tensile strength 7000 psi. And without sacrificing toughness. Actually, moly improves toughness at least as much as strength.

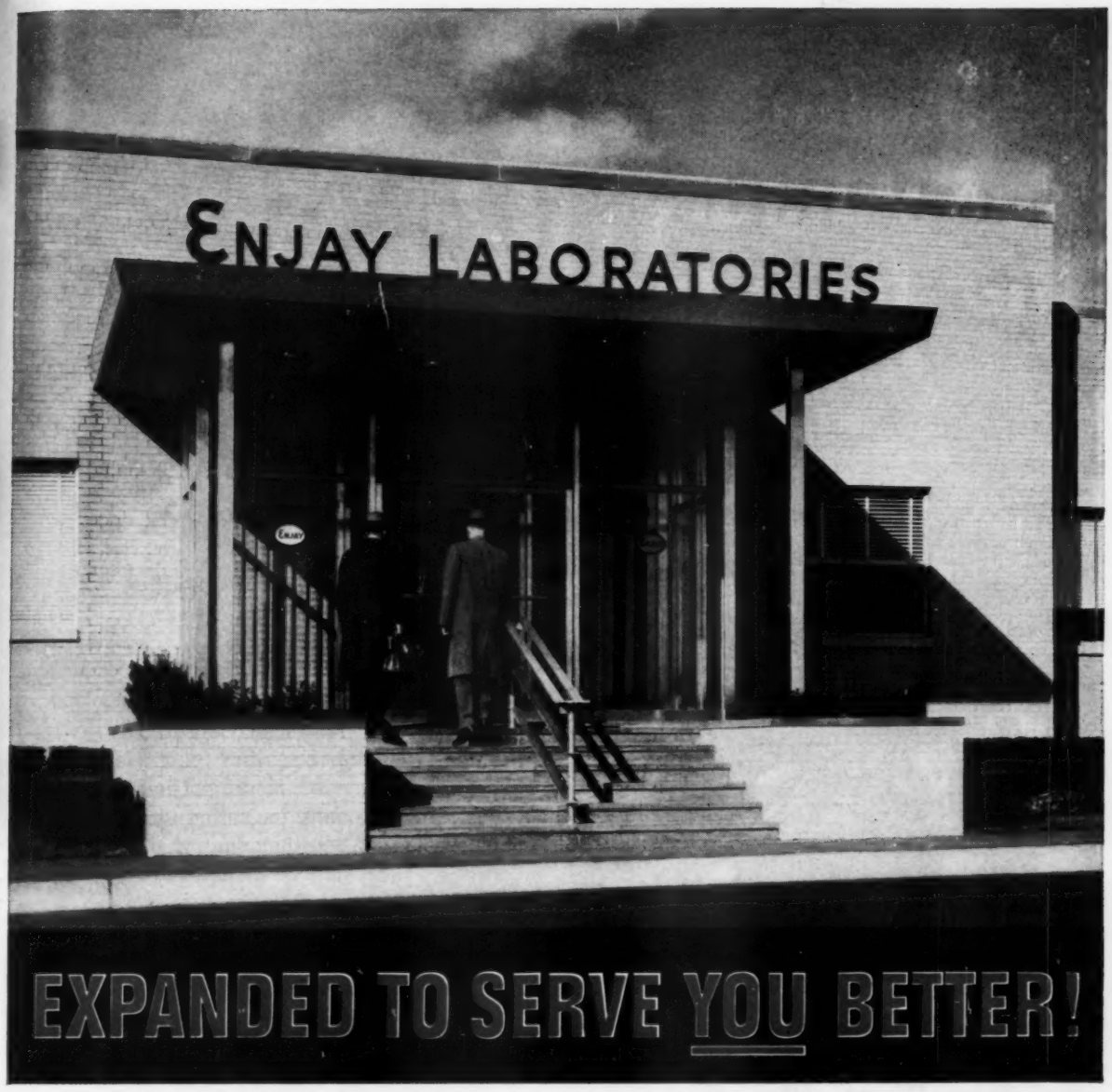
What's more, versatile moly aids in obtaining uniform response to heat treatment . . . and in producing machinable, growth-resistant castings. Moly is easy to use, too. With most grades of cast iron, moly requires no change in the character of the charge, normal melting practice, or the base metal. And foundrymen like the fact that the small additions necessary may be made at the spout or in the ladle.

Write now for "Why Moly Iron". It's the full story of how and why moly adds strength faster than hardness, how it increases fatigue and torsional strength—in short why moly makes better cast iron. Climax Molybdenum Co., Dept. 11, 500 Fifth Avenue, New York 36, N. Y.

CLIMAX MOLYBDENUM

Circle 534 on page 19





EXPANDED TO SERVE YOU BETTER!

The Enjay Company proudly invites you to inspect the new polymer wing of the Enjay Laboratories, located in Linden, N. J. Continuing the tradition of pioneering in petrochemicals, Enjay has built this new laboratory addition for application research and development exclusively in the polymer division.

With the latest technical equipment and top scientific talent, this new laboratory enables the Enjay Company to give the best possible product application service, as well as furthering Enjay's own product research program.

High speed electronic data processing equipment helps the Enjay scientists solve your compounding problems in record time. In developing new products, or improving old ones, call on Enjay for top-notch assistance. Contact your Enjay representative for further information.

ENJAY BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

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Pioneer in Petrochemicals

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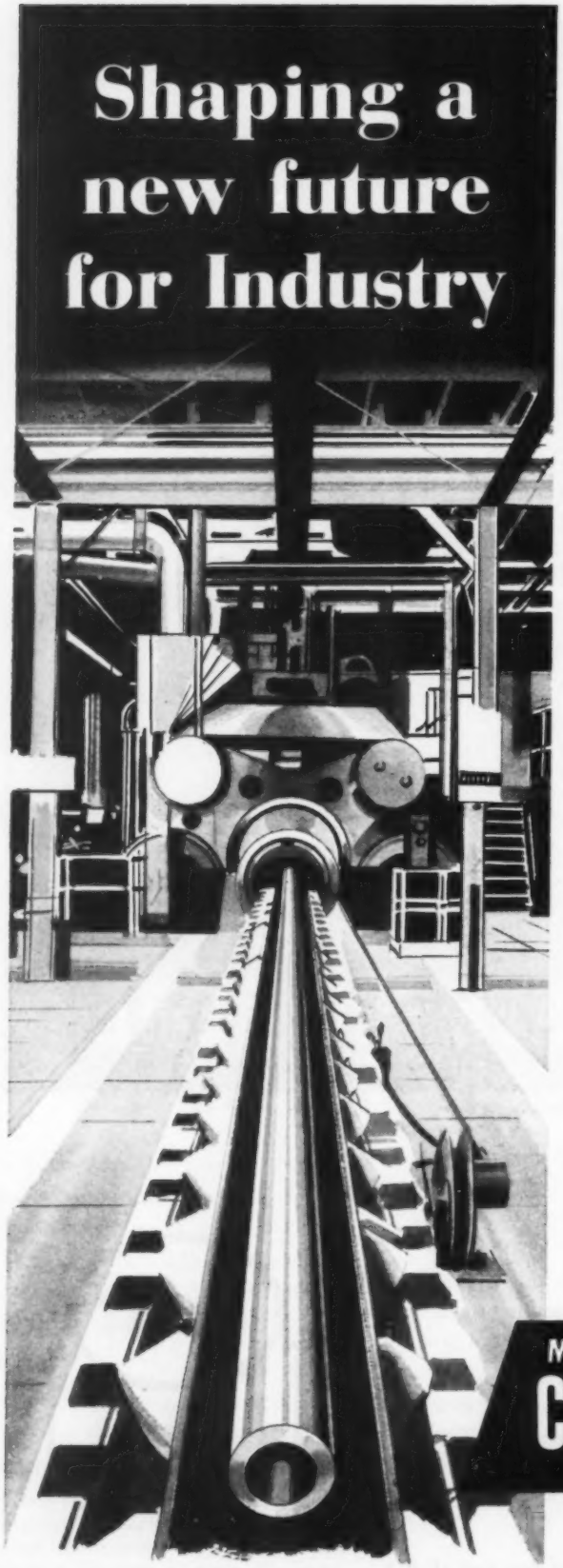
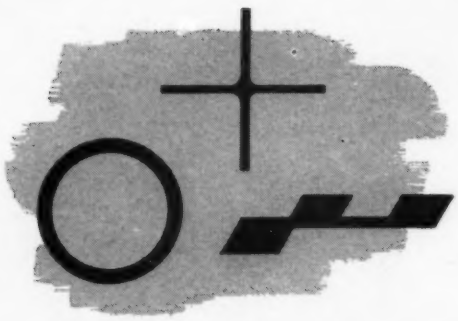
Circle 535 on page 19

Shaping a new future for Industry





CURTISS-WRIGHT extrudes steels in shapes, lengths and sizes never before possible

Curtiss-Wright's Metals Processing Division is pushing steels into new uses for all industries. Shapes and sizes never before possible are being extruded in constantly increasing tonnages from alloy steels, stainless, titanium and other metals.

Starting with billets weighing up to 9000 pounds, the world's largest horizontal steel extrusion press moves the metal into shapes of virtually any profile that can be circumscribed by a 20-inch circle. Or, in a matter of seconds, the raw material may become heavy wall tubing up to 22 inches in diameter.

The 12,000 ton extrusion press and the complete facilities of Curtiss-Wright's Metals Processing Division are ready to go to work for you . . . to advance the design and production of metal products beyond the limitations of conventional equipment. Qualified engineering consultation available at all branch offices.

71 Grider Street

METALS PROCESSING DIVISION

CURTISS-WRIGHT

CORPORATION • BUFFALO, N. Y.

Metals Processing Division Branch Offices:
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ELECTRONICS • NUCLEONICS • PLASTICS • METALLURGY • ULTRASONICS • AVIATION

NEW THREAD CUTTING FASTENER

- LOW COST
- RE-USABLE
- SELF-LOCKING
- VIBRATION-PROOF
- SPRING TAKE-UP

Pulls up tight without backup on flat or contoured surfaces

Specially designed to hold die-cast or cold-forged name plates, emblems and trim against sheet metal surfaces, DOT's new T. C. F. cuts clean, deep threads on unthreaded studs, even those that are chrome plated. Immediately available to fit 1/8" and 3/16" studs.

When used with its pre-assembled plastic sealer, the new T. C. F. makes a watertight seal. The sealer *precedes* the fastener onto the stud so that it is not damaged by the thread-cutting process.

Available *in quantity* with or without sealer from Monadnock Mills subsidiary and Carr Fastener Division.

United-Carr's design staff is ready to apply the same engineering creativity that produced the T. C. F. and thousands of other special-purpose fastening devices to the solution of your special fastening problems. Field representatives are located in most principal cities.

T.C.F. for 1/8" stud shown actual size. Also available for 3/16" stud.

T.C.F. for 1/8" stud with plastic sealer.

MONADNOCK MILLS
SUBSIDIARY
San Leandro, California

DOT T.C.F.
THREAD CUTTING FASTENER

CARR FASTENER CO.
DIVISION
Cambridge, Massachusetts

UNITED-CARR FASTENER CORPORATION

Circle 537 on page 19

XUM

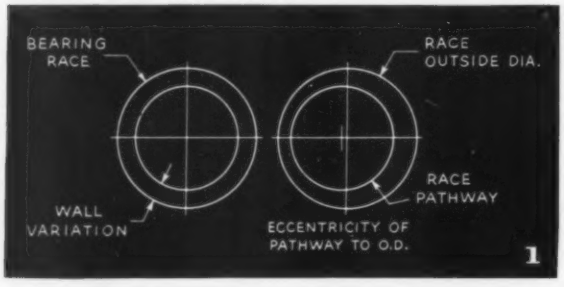
The Inside Secrets of Smoother Performance

How HYATT quality controls assure race concentricity, roller diameter uniformity and other internal essentials of smoother, longer-lived cylindrical roller bearings . . .

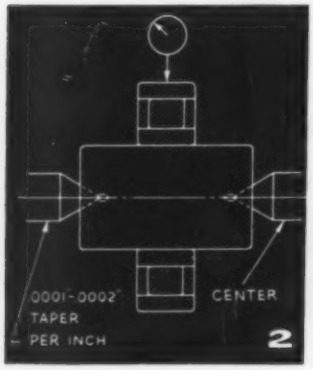
The running accuracy and smoothness of a roller bearing is governed primarily by its internal dimensions and clearances. The most important of these are:

1. CONCENTRICITY OF RACE DIAMETERS

Eccentricity of race diameters is usually interpreted in terms of *wall variation*, Figure 1, on the individual components and in terms of *radial run-out* on the assembled bearing. The



assembled bearing is usually mounted on an arbor, Figure 2, having a slight taper (.0001″ to .0002″ on the diameter per inch of length) and the radial run-out indicated as shown. The radial run-out is the difference between the minimum and maximum readings obtained when rotating the outer race one revolution with the arbor stationary for outer race radial run-out, or rotating the arbor one revolution with the outer race stationary for inner race radial run-out.

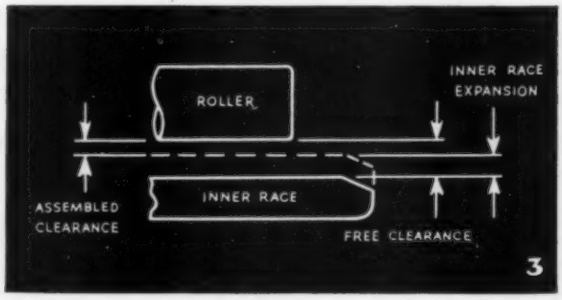


2. UNIFORMITY OF ROLLER DIAMETERS

Another factor governing running smoothness is *roller diameter uniformity*. This is usually obtained by segregating the rollers into diameter variation classes of .00005″, .0001″, or .00015″, depending on the bearing size and the nature of the application, and assembling only rollers of the same group into a given bearing. Gauging for this segregation necessarily rejects excessive taper.

Uniformity of roller diameters is important for another purpose. It provides the user with a bearing in which the internal diametral clearance is controlled within the closest possible limits. The rollers are matched with races which are segregated for pathway size in a fashion similar to the rollers, usually to twice the diameter limits of the rollers. The internal clearance can thus be manipulated at will by combining various diameter classes of races and rollers; but once a particular range is selected, it will remain constant within the combined limits of the roller and race pathway diameter limits. Here, again, a tapered condition of the race pathway is automatically rejected.

Obviously, the internal clearances of commercial bearings must be standardized for the practical reasons of cost and availability, but the clearance values have been so selected that under the specified fits the *running* clearance is at the most desirable minimum, depending on bearing type and size. Figure 3 (magnified).

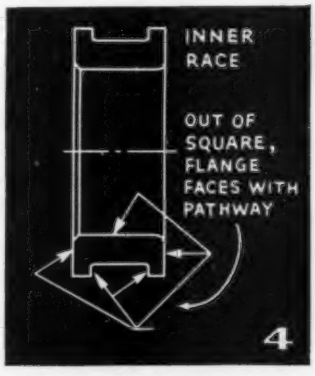


Checking wall variation, flange run-out and race end squareness on combination gauge.

3. SQUARENESS OF ROLLER ENDS AND FLANGE FACES

One other tolerance that contributes to the running efficiency of HYATT Hy-Load Series Bearings of the flanged race type is the *squareness of roller ends with roller diameters* and the *squareness of flange faces with the race pathways.*

Flanged race bearings are commonly used for locating shafts laterally and for running conditions of light and intermittent thrust load. For best operating results, the ends of the rollers must be flat and square with the diameter within a matter of tenths. The lateral clearance between the roller and the race shoulders must also be held to a minimum. This means close tolerances on roller length and race pathway width, and the flange face, Figure 4, must be square with the roller pathway. When all these conditions are satisfied, there will be no tendency for the rollers to skew and raise the operating temperature of the bearing, nor will there be any unusual force on the separator or cage with a tendency toward wracking and noisy operation.



The *side run-out* of the individual races or the *out-of-square* of the ends with the fitting diameters is also important, especially in applications where a number of parts are held together endwise and where the pressure might be sufficient to tilt the race, creating a condition of excessive taper on the roller pathway with consequent roller skewing and the development of excessive heat and noise.

All these internal dimensions and clearances are so carefully controlled that HYATT Hy-Roll Bearings have built an unsurpassed reputation among design engineers for exceptionally long, smooth and trouble-free performance.

YOU WILL FIND MORE DETAILS

in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type best suited to your design requirements. Remember, HYATT is America's first and foremost maker of cylindrical roller bearings. Hyatt Bearings Division of General Motors Corporation, Harrison, New Jersey.

GM GENERAL MOTORS

HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

Circle 538 on page 19

XUM

Investigate the assembly savings made possible by P-K® self-tapping screws

Because P-K Type A Self-tapping Screws have clean, deep slots and sharp gimlet points . . . and because they are consistently uniform, Reznor Mfg. Co. enjoys important savings in the assembly of their gas heaters.

To hold the plastic handle halves of their Instant Heat Soldering Irons together, The Lenk Mfg. Co. specifies P-K Type F Self-tapping Screws. No need for a separate tapping operation. Production is increased and costs reduced—thanks to P-K Screws.

Melnor Industries, Inc. (formerly Melnor Metal Products Co.) puts assembly strength into their famous "Swingin' Spray" oscillating lawn sprinkler by fastening zinc and aluminum parts with P-K Self-tapping Screws—7 Phillips Head Type Z and 18 Type F. They start right . . . drive right . . . and stay tight.

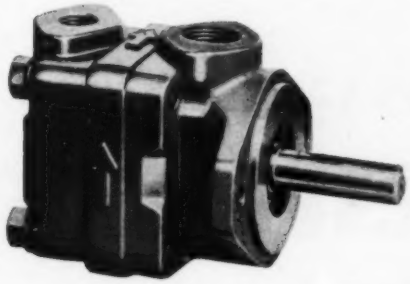
PARKER-KALON DIVISION, General American Transportation Corporation
Manufacturers of Self-tapping Screws, Socket Screws, Screwnails, Masonry Nails, Wing Nuts and Thumb Screws

PARKER-KALON® fasteners

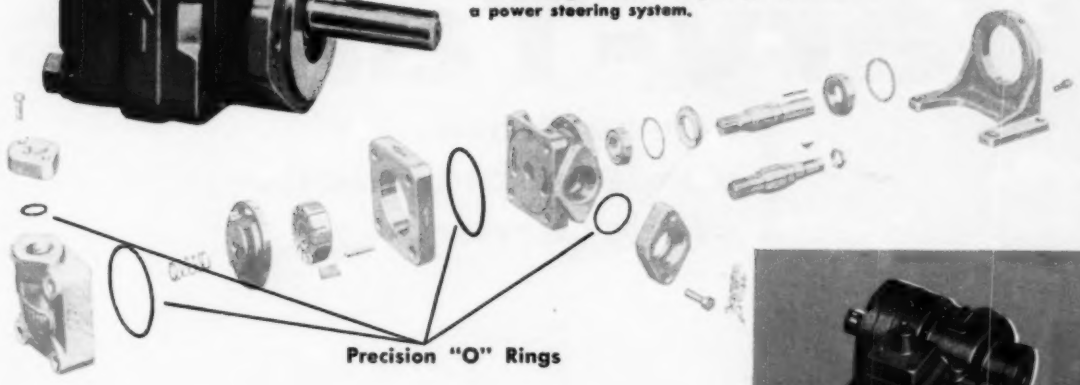
Sold Everywhere Through Leading Industrial Distributors
Factory: Clifton, New Jersey—Warehouses: Chicago, Illinois—Los Angeles, California

XUM

Precision "O" Rings protect the Heart of Hydraulic Power Steering Systems.



Precision "O" Rings provide positive hydraulic oil seal in this 1500 P.S.I. Mobile pump in a temperature range up to 160°F. Quality control in "O" Ring manufacture protects this heart of a power steering system.



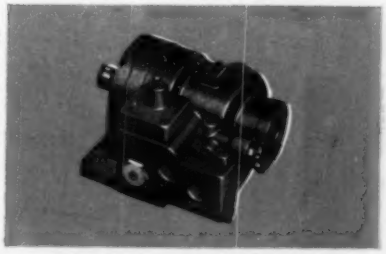
Precision "O" Rings

There can be no compromise on quality and reliability in hydraulic power steering pumps. VICKERS Incorporated, of Detroit, Mich., the world's largest manufacturer of fine hydraulic pumps, use Precision "O" Rings to assure dependable, long life performance under exacting conditions.

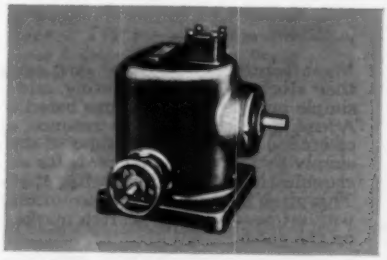
Precision "O" Rings are used in the majority of VICKERS mobile and industrial hydraulic pumps. For VICKERS Incorporated and hundreds of other manufacturers, the use of Precision "O" Rings means economical, efficient, leak-proof operation.

Precision compression molded "O" Rings are rigidly inspected – quality-controlled – meet all military and commercial specifications – the finest made! Precision can furnish the size and compound that fits your product requirements.

Place your sealing problem in the hands of an expert – the Precision engineer. He can assist you in product design. Rely on Precision, the world's largest exclusive producer of "O" Rings.

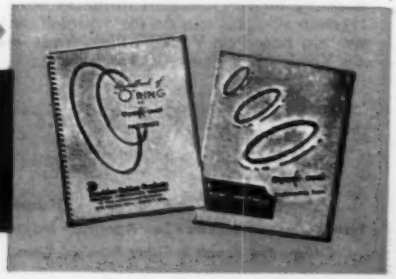


In VICKERS constant delivery vane type pumps, used on industrial machinery, Precision "O" Rings are used in pump, unloading and pressure relief valve sections to provide effective seals against hydraulic oil leakage.



In VICKERS variable delivery piston type pumps, used on industrial machinery, Precision "O" Rings give exacting service in sealing against hydraulic oil pressure up to 3000 P.S.I.

Write for your free copies of Precision catalogs on "O" Rings and Dyna-seals



Precision Rubber Products Corporation • "O" Ring and Dyna-seal Specialists

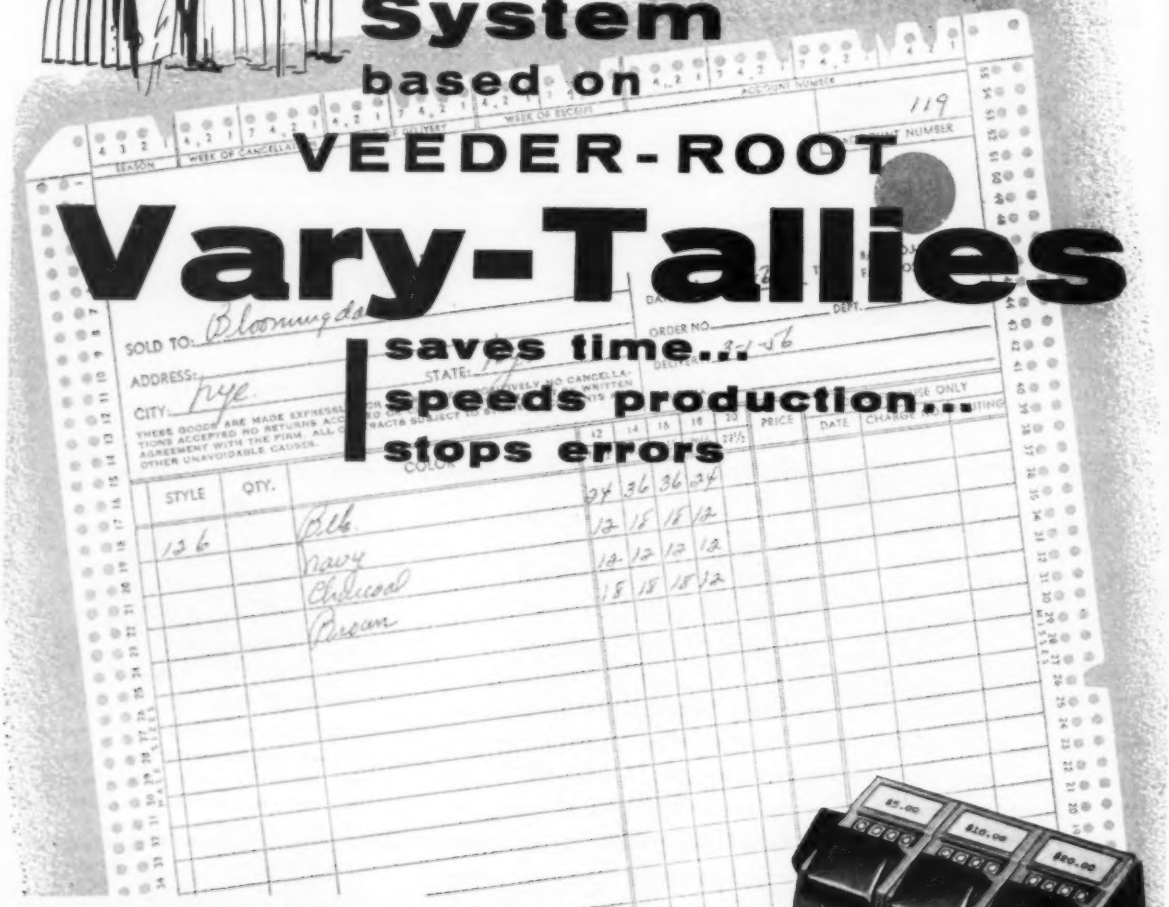
Box 431, Oakridge Drive, Dayton 7, Ohio

Canadian Plant at: Ste. Thérèse de Blainville, Québec

Circle 540 on page 19

NEW Stock-Control System based on VEEDER-ROOT Vary-Tallies

saves time...
speeds production...
stops errors



Manufacturers of skirts (or skis) can speed and simplify their stock-keeping, accounting, and payroll records with simple punched-card systems based on Vary-Tallies. A leading skirt-maker, for instance, always has complete command of several variations of styles, sizes and colors simply by lifting out the cards for any of these classifications . . . and recording them on the Vary-Tally. This gives him an instant accounting on any account, without pencil tallies, scratch marks, or telltale marks on the goods.

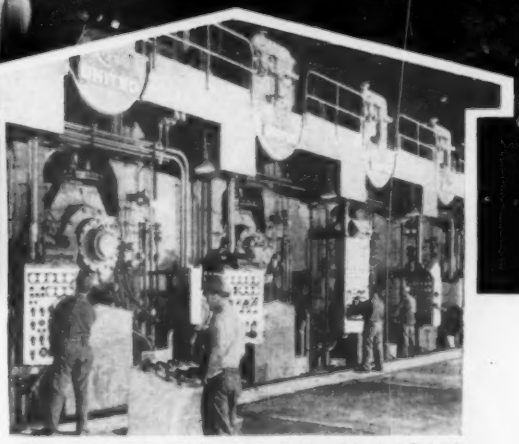
In time-checking, this manufacturer has tallied 420 items on 80 orders in 4½ minutes. *His best previous time was 40 minutes.* No copying . . . nothing but the final totals on the counter-faces.

What Production Systems Inc., Waltham, Mass., is doing for the garment industry with its "Quik-Pik" System . . . *you* can do for yourself with a similar system based on Vary-Tallies. And you can count on Veeder-Root to help you. Write:

Hartford, Conn. • Greenville, S. C. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Other Principal Cities

VEEDER-ROOT INC.
"The Name that Counts"

DIHEDRAL SPINDLE DRIVE COUPLINGS HANDLE SPEEDS UP TO 7200 FPM



Close-up shows two of five pairs of Ajax Dihedral Spindle Couplings driving 23" and 56" x 52" 4 high 5 stand tandem cold mill built by United Engineering & Foundry Co. in operation at Weirton Steel Co., a Division of National Steel Corporation.

● One of America's newest and most talked about mills is driven by ten Ajax Dihedral Spindle Couplings.

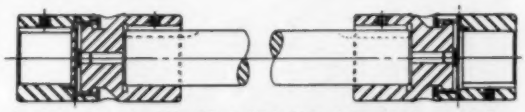
This 23" and 56" x 52" 4 high, 5 stand tandem cold mill is turning out sheet of high quality finish and maintaining close gauge tolerance at speeds up to 7200 fpm.

Uniform angular velocity made possible by Ajax Dihedral Spindle Couplings is an important factor in the performance of this high speed mill built by United Engineering & Foundry Co. for Weirton Steel Co., a Division of National Steel Corporation.

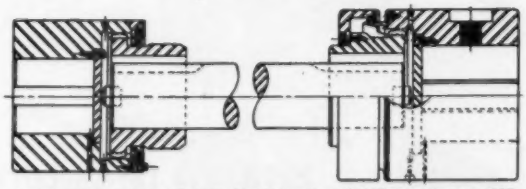
Each of these couplings delivers 2500 hp between drive stand and rolls.

The proven performance of Ajax Dihedral Spindle Couplings is writing new standards into the specifications of mill builders and new figures into the production and maintenance cost records of mill users.

The long experience of Ajax engineers is available to help you in all phases of design, application and operation. Call in the Ajax representative or write us direct.



Another typical style of Ajax Dihedral Spindle Shaft Couplings in several sizes for roll mill drives. Sketch shows 9" diameter by 5'6" overall length Ajax Dihedral Spindle Shaft Coupling. Arranged for booted lubricant retainer seal.



Showing Ajax Dihedral Spindle Shaft Coupling 6'4⅛" overall with 15¾" diameter coupling on roll end and 13¾" diameter coupling on drive end. Rated torque capacity of this Coupling is approximately 110,000 ft. lbs.

AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD, N. Y.

When you plan for COST REDUCTION — use this time-proved FORMULA

Selection from the BOSTON Gear CATALOG + **Ordering from your local BOSTON Gear DISTRIBUTOR** =

All the parts you need from the complete line of 7124 STANDARDIZED PRODUCTS

anywhere in U.S. or Canada for prompt delivery OFF-THE-SHELF AT FACTORY PRICES

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LISTS ALL PRODUCTS — replaces Catalogs No. 55, No. NP-55, and No. R-56 — Includes hundreds of NEW PRODUCTS — NEW MODELS — NEW SIZES...

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MORE SPROCKETS — New, standard stock BORED-TO-SIZE Sprockets — complete with keyway and set screw, ready to install — your choice of 76 tooth sizes, 321 stock bores. Also lists full line of SHOLD-A-GRIP taper-bored Sprockets and Bushings.

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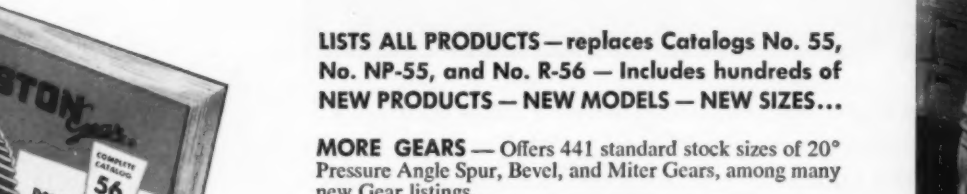
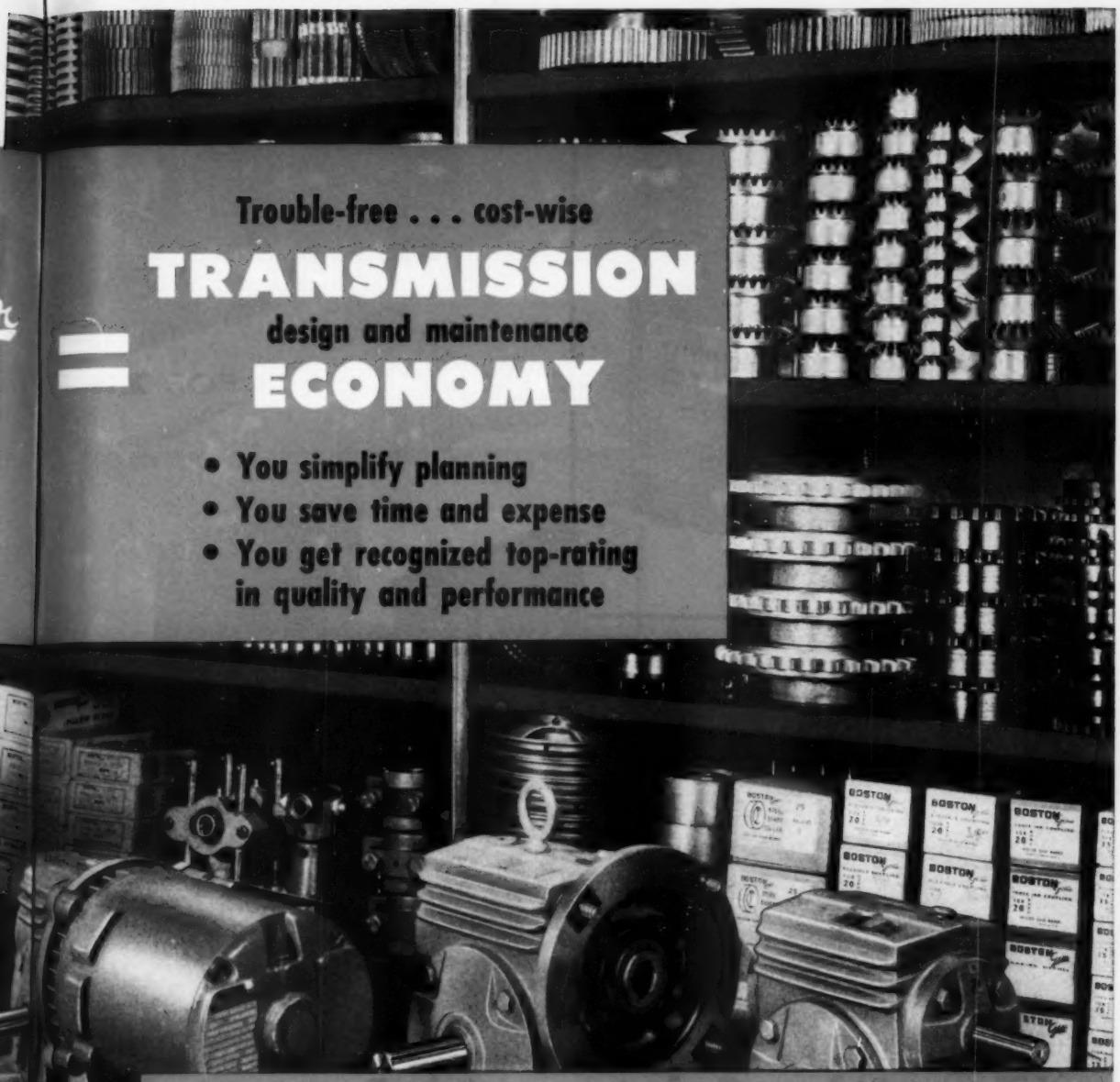
MORE BEARINGS — Lists BOSTON GEAR Bronze Bearings (Bear-N-Bronz) in 1033 stock sizes . . . and new models and sizes in Pillow Blocks, Flanged Cartridges, other products.

MORE HELP IN PLANNING — 50 pages of simplified engineering data make Catalog 56 your reliable aid for drive design, plant maintenance.
Boston Gear Works, 64 Hayward St., Quincy 71, Mass.

7124 "OFF-THE-SHELF" TRANSMISSION PRODUCTS FROM YOUR DISTRIBUTOR

— STANDARD STOCK GEARS — | SPROCKETS & CHAIN | SPEED REDUCERS —





5490-NC-23

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T FACTORY PRICES ASK FOR CATALOG

BEARINGS — OTHER PRODUCTS —

Oil-Impregnated BOST-BRONZ

BOSTON GEAR BRONZE BEARINGS

BALL BEARINGS

PILLOW BLOCKS

UNIVERSAL JOINTS

COUPLINGS

Circle 543 on page 19

XUM

MADISON-KIPP CORP.
MADISON, WIS.
DEEP-DOWN SECURITY
Good housekeeping and excellent metal control have given Madison-Kipp a most outstanding record on both ordnance and commercial products in zinc and aluminum for over a quarter of a century.
kipp
MADISON-KIPP CORPORATION

ONE LABEL FOR **AL.**

TWO LABELS FOR **ZN.**

Significant Labels *of modern metal founding at the* Die Casting Division *of*

MADISON-KIPP Corporation

Please clip this ad as a reminder to contact us when you have die casting requirements.

kipp

MADISON-KIPP CORPORATION
210 WAUBESA STREET • MADISON 10, WIS., U. S. A.

• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

Circle 544 on page 19

How 3 hours of Drafting Time was Reduced To 15 Seconds...

Any drawing details that reappear on your tracings again and again pile up high-priced man hours on purely routine work.

Title blocks, specification boxes, notes and instructions, standard components and sub-assemblies, symbols, standard cross sections—any details that recur—can now be applied in a matter of seconds.

Desired material printed on acetate sheets with adhesive applied to the face can be supplied to you in quantity at low cost. To apply, simply peel off the protective backing paper and place the acetate in position on the rear of the tracing. Rub firmly and the job is done. Resulting reproductions are always crisp and clear. When the recurring parts come up again, don't use expensive drafting time—follow the experience of drafting rooms in every major industry—use inexpensive **STANPAT.**

Prove to yourself how STANPAT saves time, effort, money. Send us your drawing details now for quotation without obligation.

Circle 545 on page 19

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STANPAT CO., Whitestone 57, N. .Y., U. S. A.

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☐ Please quote on enclosed samples

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ROSS EXCHANGER

cools oil while this Giant Hufford Uniwelder joins 20 inch tubing

Designed to handle the biggest job ever performed by the uniweld process, the 200-ton Hufford Uniwelder (shown) welds tubing up to 20 inches in diameter and 2 inches thick.

An important component of this welding giant, a Ross Type BCF Exchanger holds hydraulic oil temperature in check. Pump slippage from overheated, thinned oil is thus effectively prevented and rated power insured. Says Hufford Machine Works, Inc., "Ross Exchangers are compact, easy to install and perform satisfactorily . . . We have been using them for several years."

Like Hufford, numerous manufacturers furnish Ross Exchangers with regularity on hydraulic machinery of every description: die casting machines, metal drawing presses, extrusion presses, gear shapers, powder metal presses and fluid drives.

Not only are Ross Exchangers unmatched in thermal efficiency and ruggedness, they're pre-engineered in a wide range of fully standardized sizes to meet most needs. For detailed information, request Bulletin 1.1K5. Ross Heat Exchanger Division of American-Standard, Buffalo 5, New York. In Canada: American-Standard Products (Canada) Limited, Toronto 5, Ont.

ROSS | ROSS HEAT EXCHANGER PRODUCTS

Use WELDED STEEL for Greater Strength with Less Weight!

Being machined above is one of 164 Tripods produced and machined by Mahon for use in the world's largest continuous grinding and polishing machine to be employed in the production of plate glass. Weldments, in almost any type of heavy machinery give you greater strength with less weight—and the additional advantages of greater rigidity and predictability. If you can use weldments in your products, you can turn to Mahon for complete service including design, or redesign, fabrication, machining and assembling. The parts and assemblies illustrated here are typical of thousands of Steel-Weld Fabricated units produced by Mahon for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. You, too, will find in the Mahon organization a unique and reliable source for welded steel in any form . . . a source with unusual facilities where design skill and advanced fabricating techniques are supplemented by craftsmanship which assures you a finer appearing product embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or better still, have a Mahon sales engineer call at your convenience.

THE R. C. MAHON COMPANY • Detroit 34, Michigan

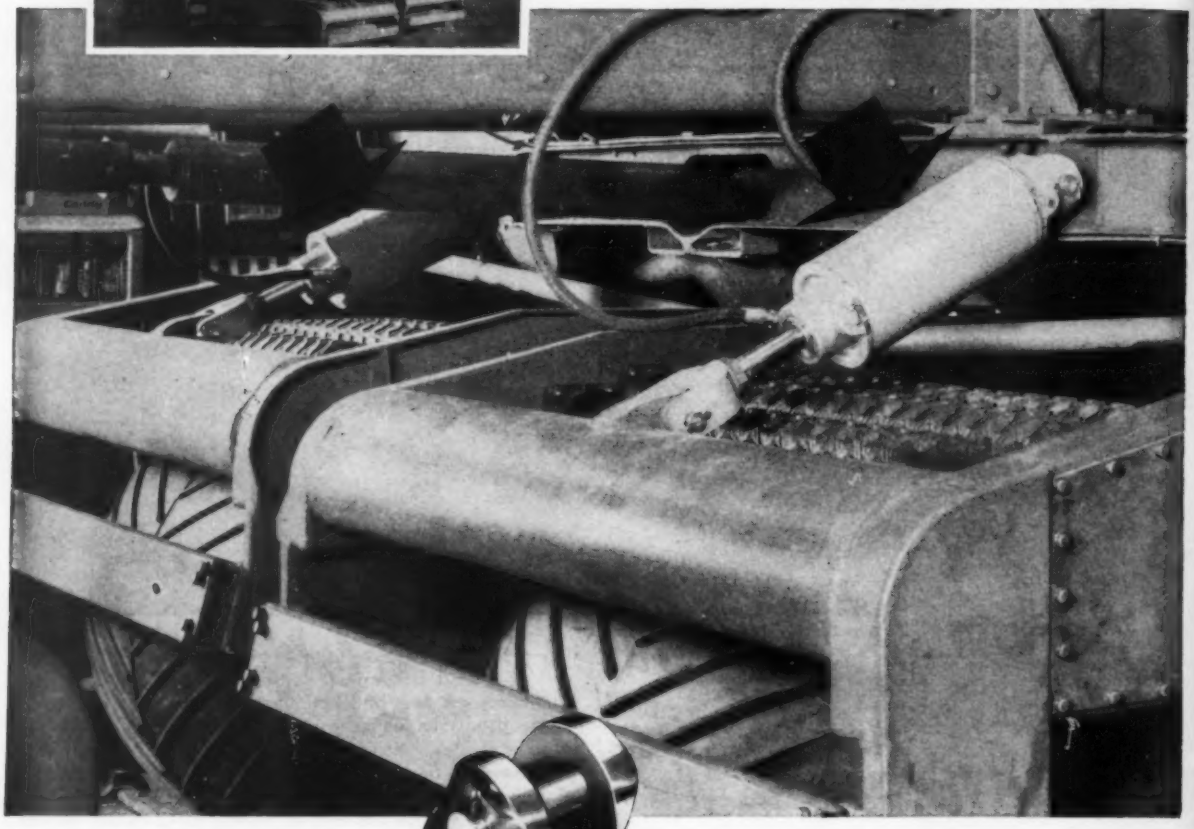
Sales-Engineering Offices in Detroit, New York and Chicago

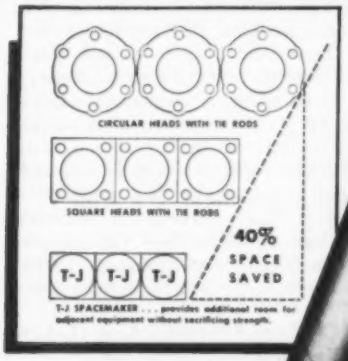
Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

XUM

Arctic Cargo Carrier Depends On T-J Spacemaker CYLINDERS




CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
40% SPACE SAVED
T-J
T-J
T-J
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

ALL MODELS . . . OFF SHELF DELIVERY

MEETS WITH ALL JIC RECOMMENDATIONS

Saves 40% Space!

No Tie Rods For Greater Strength

Differential axle loading through T-J Spacemaker Air Cylinders forms a controlled walking beam in this Teracruiser, designed and produced for the Army Ordnance Corps by the Four Wheel Drive Co., Clintonville, Wis.

Weight of cylinders was important factor in choosing T-J Spacemakers, which reduce weight while providing same displacement and extra high safety factor. Fast delivery and space-saving features also favored T-J. Exclusive with T-J are new Super Cushion Flexible Seals for Air (to 200 P.S.I.) . . . and New Self-Aligning Master Cushion for Oil (to 750 P.S.I.). Hard chrome plated bodies and piston rods are standard, at no extra cost. Wide range of styles, capacities . . . 64,000 combinations *off the shelf!* Write for bulletin SM-155-3. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVETORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

Circle 548 on page 19

Circle 549 on page 19→

• Tough, corrosion fighting stainless steel that will resist weather, road abrasion and flying stones, and return to its original brightness when wiped with a damp cloth . . . that's what car buyers want these days.

• Designers with their fingers on the public pulse know this, and that's why next year more stainless steel will be used by the car manufacturers than ever before. A good percentage of this stainless steel will be supplied by Sharon . . . for more than half a century a leading producer of quality automotive steels.

SHARON Stainless Steel

SHARON STEEL CORPORATION Sharon, Pennsylvania

DISTRICT SALES OFFICES: Chicago, Cincinnati, Cleveland, Dayton, Detroit, Grand Rapids, Indianapolis, Los Angeles, Milwaukee, New York, Philadelphia, Rochester, San Francisco, Sharon, Seattle, Montreal, Que., Toronto, Ont.

XUM

For Push-Pull Rod Assemblies

HEIM

Unibal ROD ENDS

The common function of all push-pull rod assemblies is the transmission of force and motion from one machine component to another.

For their ease of assembly, smooth operation, comparatively low cost, as well as ability to correct misalignment, choose Heim Unibal Rod Ends.

In the operation of the Sweater-Looper, made in Philadelphia by John W. Hepworth & Co., there is a horizontal drive rod, a vertical drive rod, and a needle drive rod. At both ends of each drive rod are Heim Unibal Rod Ends — for smooth, trouble-free, continuous production.

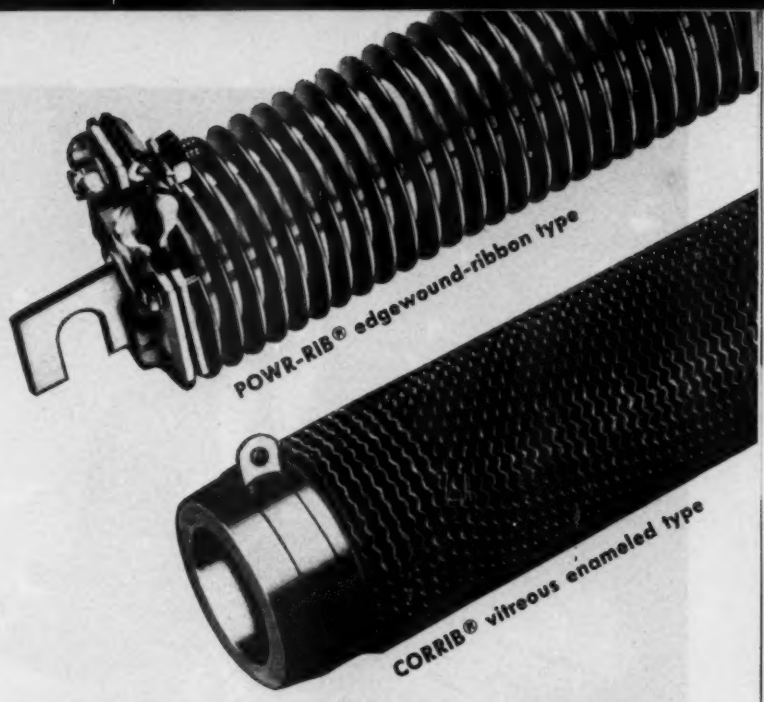
The Hepworth Sweater-Looper is used for all types of sweater collars, sleeves, and shoulders. Collars can be set on a completely assembled knitted garment in a single continuous operation. Heim Unibal Rod Ends perform so well on the sweater-looper that Hepworth has redesigned their hosiery-looper to include Heim Rod Ends in the linkage assemblies.

Write for complete catalog, or for any engineering advice.

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

specify OHMITE® *Power Type* RESISTORS for high current low resistance applications—



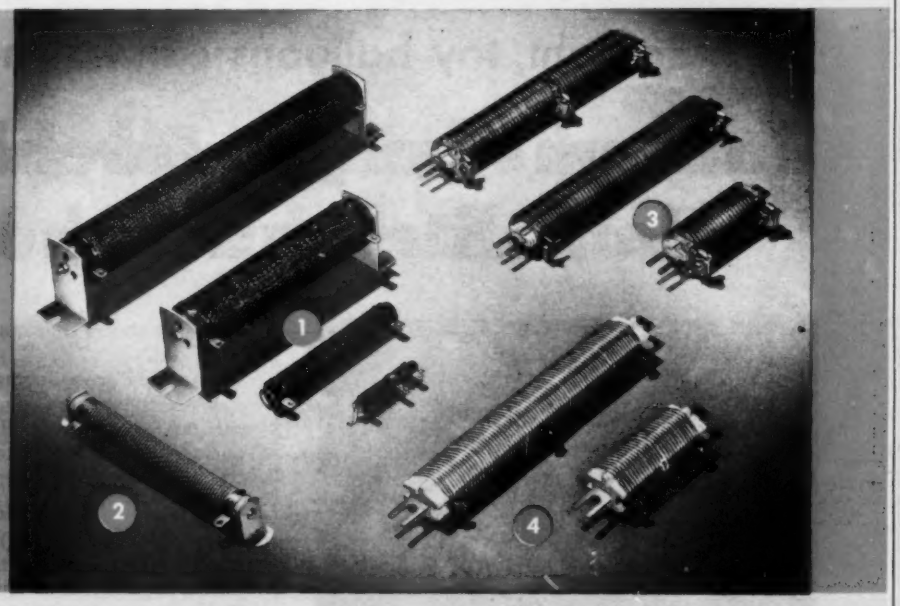
The Ohmite line of specialized CORRIB and POWR-RIB resistors solves your high-current, low-resistance problems. The four basic types of Ohmite units (shown below) handle a wide range of special power resistor needs. They are designed for continuous or intermittent duty and provide dependability for heavy-duty applications. Available in Fixed or Adjustable "DIVIDOHM®" Types.

IN STOCK—22 Corrib Resistance Values in 300 Watt Size (Core 8½" x 1⅛").

IN STOCK—26 Powr-Rib Resistance Values in 5 Section Size (17⅞" long).

Write for Bulletin 144

1. **CORRIB® vitreous-enameled corrugated-ribbon type**
   Fixed, tapped, and adjustable types in 25 sizes, 90 to 1500 watts. Resistances from .04 to 110 ohms.
2. **CORRIB® bare threaded tube type**
   For continuous or intermittent operation at higher than normal 375°C temperature rise. In two sizes, from 0.36 to 4.25 ohms.
3. **POWR-RIB® edgewound-ribbon type**
   Has ceramic core, sectionalized to resist shock. Four sizes. Values .043 to 1.6 ohms; 24 to 95 amps.
4. **POWR-RIB® round-wire type**
   Has sectionalized core similar to ribbon type. Four sizes. Values from .69 to 25 ohms; 5.1 to 18.4 amps.



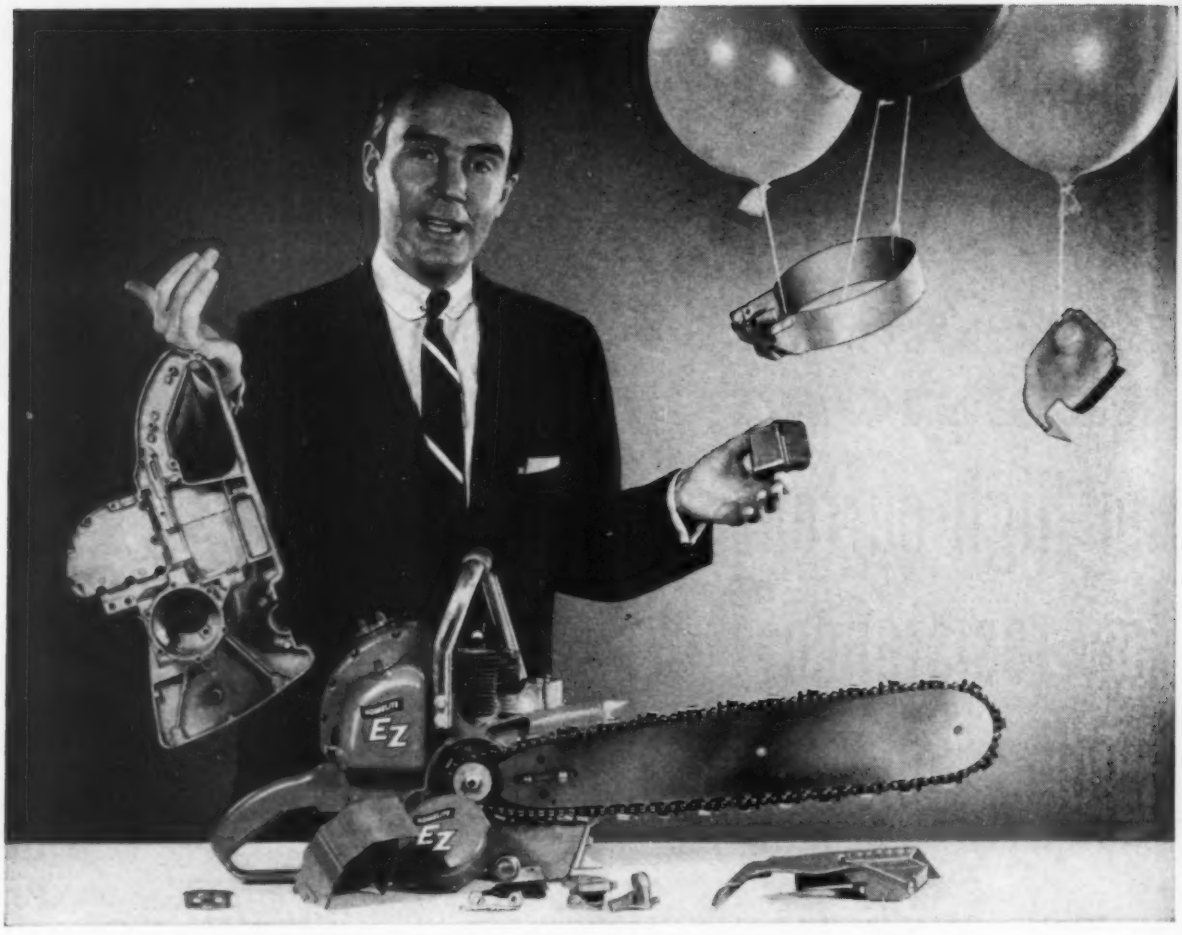
Be Right with OHMITE®

RHEOSTATS
RESISTORS
RELAYS
TAP SWITCHES
TANTALUM CAPACITORS

OHMITE MANUFACTURING COMPANY, 3618 Howard Street, Skokie, Illinois (Suburb of Chicago)

Circle 551 on page 19

XUM



"So light, toy balloons can lift them..."

Bantam-weight Doehler-Jarvis Homelite pack 5 horsepower

The gasoline-engine-driven EZ is an eager little beaver . . . whips through an 18-inch pine in 14 seconds, an 8-inch oak in 5.

This just shows that magnesium die castings are the lightest of light.

And they are amazingly strong.

With these particular Doehler-Jarvis magnesium die-castings, for example, Homelite (division of Textron Inc.) packs 5 horsepower into their heavy-duty EZ direct drive chain saw and still keeps weight down to 19 pounds.

Design aids lightness, too

This sales-building lightness and strength is not based solely on the use of magnesium. Homelite and Doehler-Jarvis engineers also eliminate practically all excess metal. They do this by taking advantage of minimum thickness die-cast sections. Ribs provide rigidity.

They do away with much machining, too. And cast in several competitive advantages. For example:

- Die casting establishes accurate machining base points. These permit multi-jig production and both improve

magnesium die castings help into this 19-pound chain saw

dimensional accuracy and reduce cost.

- Servicing instructions in bas-relief are die-cast right into certain parts.

What's more, Doehler-Jarvis delivers the raw parts with near perfect "as cast" surfaces... surfaces that need only degreasing to accept a high-quality finish.

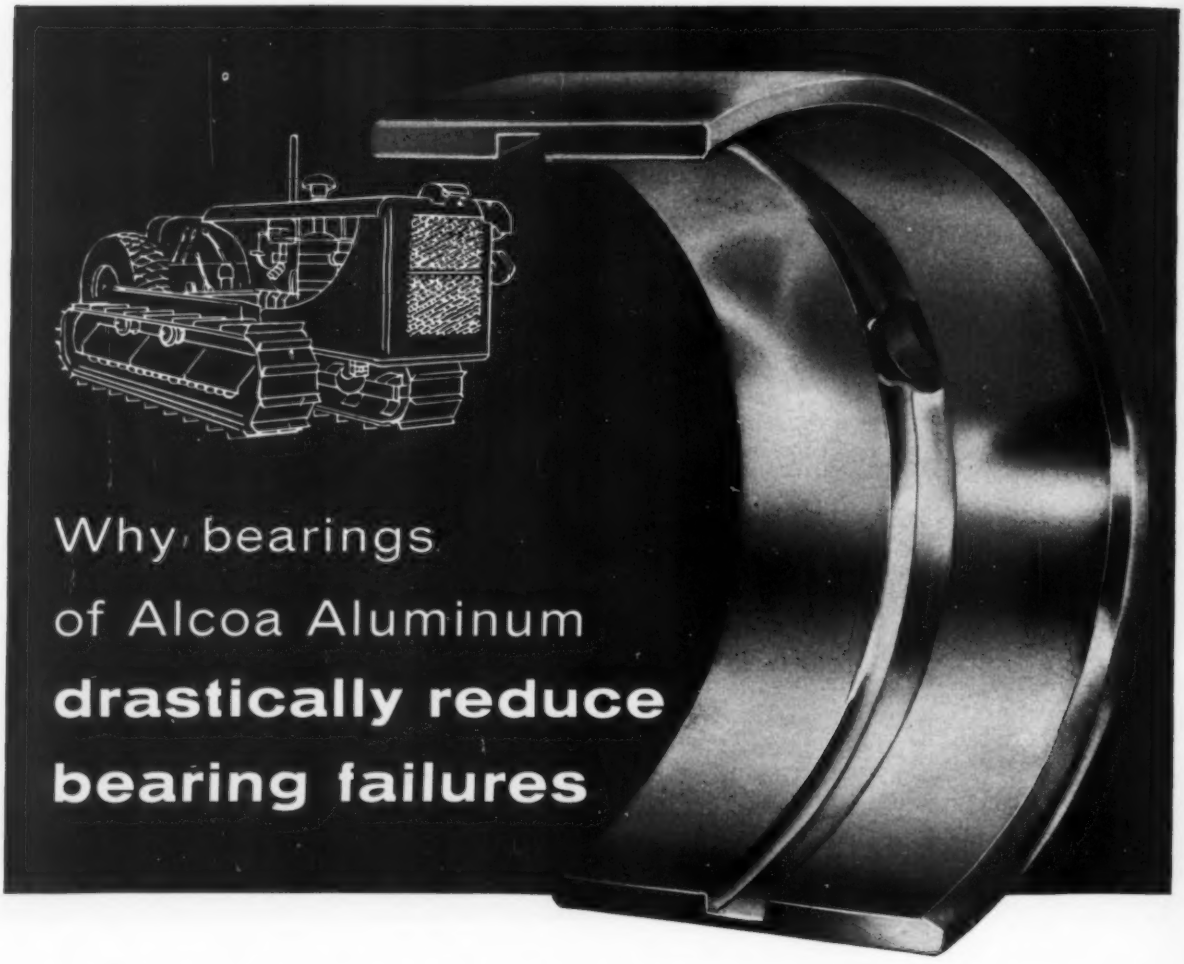
PA reports outstanding service

EZ sales got off the ground fast. Within weeks Homelite needed twice the projected quantity of castings. With a separate plant at Batavia, N. Y. for producing magnesium die castings, Doehler-Jarvis was able to respond quickly. Says Homelite's Purchasing Agent, "Those fellows out in Batavia have certainly done an outstanding job for us."

And you can be sure that Doehler-Jarvis *does* do outstanding work. Right now we're operating some 20,000 dies for some 1400 firms. Call us in on *your* next job.

Doehler-Jarvis
DIVISION OF NATIONAL LEAD COMPANY
General Offices: Toledo 1, Ohio

In Canada:
Barber Die Casting Co. Limited
Hamilton, Ontario



Why bearings of Alcoa Aluminum **drastically reduce bearing failures**

A major implement company switched to solid aluminum for main connecting rod and thrust bearings in tractors. Result: a *drastic* reduction in bearing failures . . . *much* longer bearing life.

In hundreds of different kinds of applications solid aluminum bearings are outperforming bronze and babbitt because aluminum has an *unmatched combination of advantages.*

Highest load capacity—No other material is in the same league with aluminum for load-carrying capacity—up to 10,000 psi on projected area. Only aluminum can be used for solid bearings in heavy-duty service.

20° cooler running—There's less chance of seizure with aluminum bearings—they run up to 20° cooler than others.

Excellent conformability—Aluminum is a very ductile metal, conforms readily to misalignment or nonparallelism.

Handles dirt well—Aluminum embeds dirt particles better than bronze but not as deeply as babbitt. Dirt rolls out easily and into the filter.

No corrosion problem—Oil additives don't hurt aluminum bearings. No protective coatings are needed.

No failure damage—With solid aluminum bearings there is, of course, no hard backing material to damage the shaft in event of bearing failure.

Great design flexibility—Aluminum bearing alloy is also a *structural* material so you can do such interesting things as designing rocker arms and connecting rods that need no bearing inserts, or water-cooled bearings with integral cooling passages.

Find out more about cast bearings of solid Alcoa® Aluminum. Check your bearing manufacturer or write: Aluminum Company of America, 1986-M Alcoa Bldg., Pittsburgh 19, Pa.

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

Your Guide to the Best in Aluminum Value

Circle 553 on page 19

There are 69 reasons why

—Diehl can build better motors. For 69 years, successive generations of Diehl motor specialists have applied their accumulated know-how to solving the power problems of widely divergent types of industries. In the smallest shops or the largest plants—all over America—Diehl men study the problem along with the customer. Name your motor requirements—no matter how "different," it's more than likely that an almost-similar situation has been recently brought to a successful conclusion with Diehl action. Here's where Diehl know-how helps you. The right answer and the right motor—*at the most reasonable cost*—can be yours, fast! Designed and built for your job. Get all the power and get it right—from Diehl.

You invest in Performance

when you design with DIEHL.

INTEGRAL AND FRACTIONAL HORSEPOWER MOTORS ARE AVAILABLE IN A WIDE RANGE OF TYPES AND SIZES

Diehl

DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING COMPANY
Finderne Plant, Somerville, N. J.

MD

Please send me Bulletin No. 3526

Name_____

Company_____

Street_____

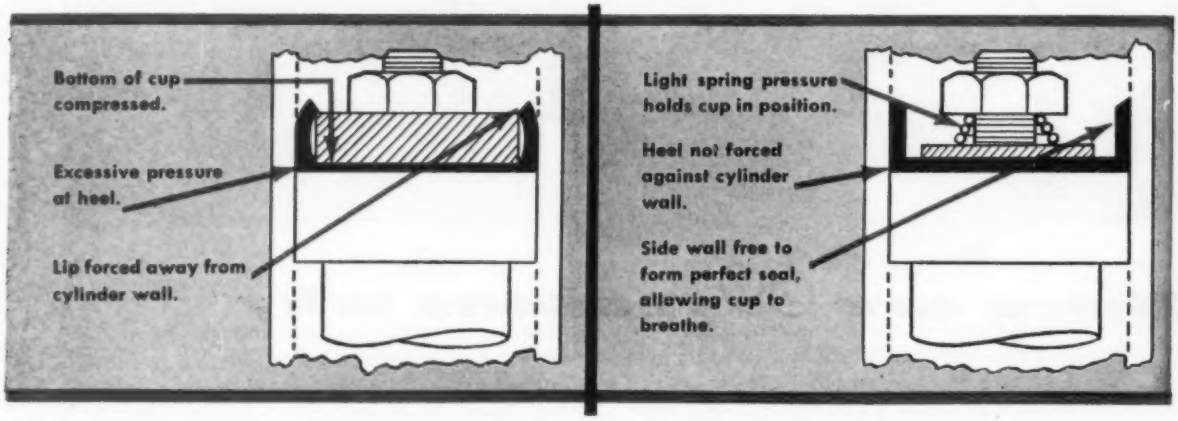
City_____ State_____

Circle 554 on page 19

ANOTHER
NEW DEVELOPMENT
IN PACKING DESIGN

SPRING MOUNTED CUPS

Provide Better Seal.....Reduce Friction


Bottom of cup compressed.
Excessive pressure at heel.
Lip forced away from cylinder wall.
Light spring pressure holds cup in position.
Heel not forced against cylinder wall.
Side wall free to form perfect seal, allowing cup to breathe.

Houghton hydraulic research has come up with one of the chief answers to the problem of excessive friction, short cup life and chatter so often encountered in cup packing installations. Now, instead of the squeezing action of bolting the cup packing in place between the piston and the follower plate, you can use a spring mounting with preformed cup packings. The illustrations show the obvious advantages.

This leadership in hydraulic know-how is typical of Houghton, which makes all types of hydraulic and pneumatic packings, as well as a complete line of hydraulic oils and fluids.

Standardize on Houghton. You'll get the newest first—and the best always. Call your Houghton Man. He will explain their Hydraulic Service. E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Pa.

. . . products of

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

Rolling up the Miles

Rolling Down the Costs

Write for your copy of
"STAINLESS STEEL IN PRODUCT DESIGN"

40 pages of useful engineering and fabricating data, including practical examples showing where, when and how stainless steel improves design, adds benefits, helps sales.

ADDRESS DEPT. MD-84

Ask any user: stainless steel trailers *do* roll up extra miles. In fact, they can roll indefinitely because of their great strength and resistance to rust and wear . . . qualities in which *no other metal* matches stainless steel. Of course, that longer operational life means lower over-all expense.

But stainless helps roll down the costs (and UP the profits!) in other ways. It's so strong that thin-wall sections and structural members can be used, permitting greater payload capacity and offering additional savings in operating expenses. Painting isn't needed, and maintenance is cut to a whisper.

Such properties make stainless steel an ideal material for trailers, trains, planes, etc. They qualify it for myriad other applications, too. Chances are that *you* could use it when your product (or process equipment) requires superior strength, corrosion resistance, heat resistance, sanitary qualities, ease of fabrication, durability and attractiveness. ● We'd be pleased to discuss it with you—anytime you say or anywhere you'd like to meet. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

WSW 6062 B

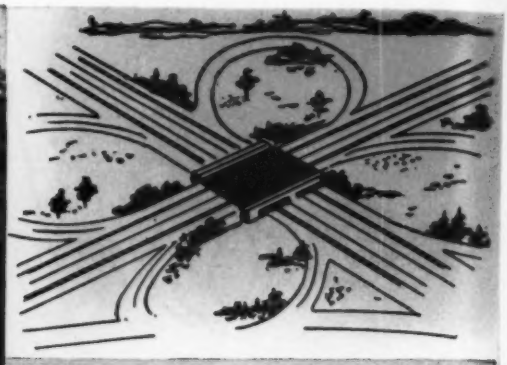
Make it BETTER-and LONGER LASTING-with

AL Stainless Steel

Warehouse stocks carried by all Ryerson Steel plants

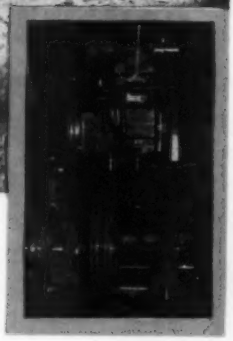
AL ALLEGHENY LUDLUM

Circle 556 on page 19



GALION 104 Motor Grader, above, uses Eastman Assemblies on *EIGHT* Hydraulic controls for more accurate, effortless and economical grading. Close-up, left, shows powerful Hydraulic Circle Turn for famous Galion "Reversible" Moldboard.

BARBER-GREENE Bituminous Finisher, right, automatically lays level finish for smoother, safer travel. Close-up shows Eastman Hydraulic Hose Assembly delivering 2,700 lbs. pressure to raise and lower finishing screed.



Smoother, Safer Roads

BUILT WITH HYDRAULIC POWER

DELIVERED THROUGH

Eastman

HYDRAULIC HOSE ASSEMBLIES

ALWAYS SPECIFY

EASTMAN Pressed-on, Reusable and Renewable Couplings for high and low pressure air, gas, water, paint, grease and hydraulic fluids. Eastman Straight and Angled Adapter Unions.

Smoother, safer highways are being built today through the application of modern engineering and the use of modern equipment—much of which is hydraulically operated—using Eastman Hydraulic Hose Assemblies.

GALION—pioneer builder of road machinery—whose Motor Graders and Rollers are used 'round the world—first used hydraulic controls as early as 1927. Eastman Mfg. Co. pioneered in the development of Hydraulic Hose Assemblies in 1926—and *Galion is Eastman equipped today!*

BARBER-GREENE—whose Bituminous Road Finishers have been used at one time or another on almost every road ever built—also uses Eastman Hydraulic Hose Assemblies. Hydraulic power is used to raise and lower the all-important mechanism which lays a level finish—regardless of irregularities in the base. Barber-Greene's founding date of 1916 closely parallels Eastman's of 1914—and *Barber-Greene is Eastman equipped today!*

EASTMAN—*first in the field*—is proud to have pioneers such as Galion and Barber-Greene—as well as many other leading American manufacturers—use Eastman Hydraulic Hose Assemblies. Look to Eastman for *continued leadership* in engineering and design for quality of material and workmanship—plus better-than-ever service through expanded production facilities of our new, modern plant.

SAFEGUARDING INDUSTRY'S Lifeblood of Mobile Power

Eastman

first in the field

MANUFACTURING COMPANY

Dept. MD 12, Manitowoc, Wis.

BUILD BETTER ROADS TODAY · FOR A GREATER AMERICA ·

See you at the ROAD SHOW CHICAGO Jan. 28-Feb. 2, 1957

BOOTH NO. 359—SECTION A

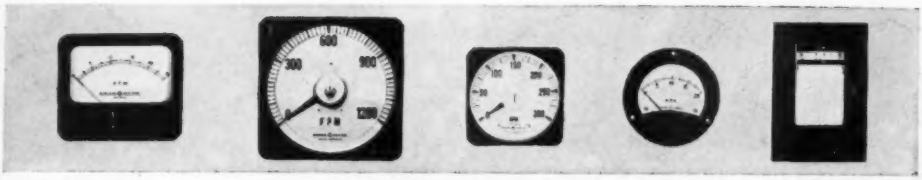
(North Hall, 2nd floor)

Circle 557 on page 19

General Electric Speed Measuring Systems:

Handsome Appearance and Top Quality Increase Customer Acceptance and Resale Value

G-E application engineering and fast shipment help you get the right system when you need it



COMPLETE LINE of indicators and recorders to choose from offers you the exact type speed measurement you require.

General Electric speed measuring systems are offered in a complete line for every application; each system you buy is *tailor-made* to meet your requirements.

Here are 9 reasons why you get optimum performance for your investment with G-E speed measuring systems:

1. Handsome appearance of G-E indicators contributes to the good looks of your product and increases salability.

2. Top quality of every instrument assures you of extreme reliability under severe conditions.

3. High accuracy of ±1% of full scale is made possible by factory calibration of generator and indicator together.

4. Small size of both generators and indicators gives you greater latitude when selecting a mounting position.

5. Excellent readability of indicators is provided by long scales and large numbers. Non-parallax glass of DB-16 and DB-18 indicators allows reading from almost any angle.

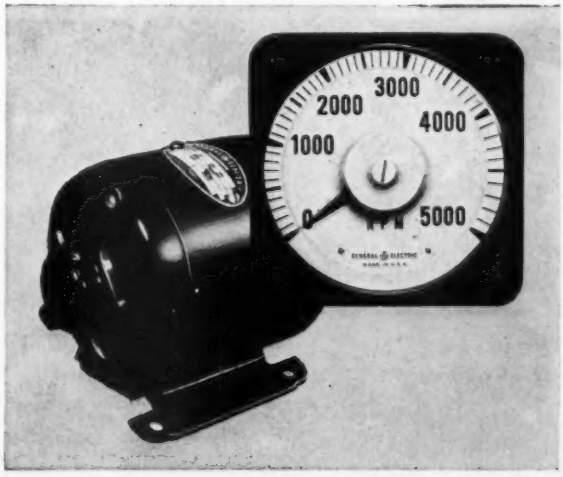
6. Totally enclosed, both generators and indicators are fully protected from dust and dirt. Explosion-proof enclosures are available on some models.

7. Fast shipment of complete systems helps you meet commitments.

8. G-E application engineering is available to you on request to help you solve your speed measuring problems and select the proper equipment.

9. Any legend you require will be marked on your G-E tachometer indicator scales. Your instruments may be calibrated in units such as feet per minute, inches per minute, spindle rpm or any related speed. Manufacturer's or customer's name may also be imprinted on the scale face.

If you would like additional information on General Electric's complete line of speed measuring systems, call your nearest General Electric Apparatus Sales Office or write for Bulletins GEC-1258 and GEA-6427 to Section 585-57, General Electric Company, Schenectady 5, New York.



EXCEPTIONAL ACCURACY is made possible because generator and indicator are calibrated as a unit at the factory.

GENERAL ELECTRIC

Circle 558 on page 19

Circle 559 on page 19→

GENERAL ELECTRIC ANNOUNCES

static switching systems

General Electric's new static switching systems have been designed to increase significantly the dependability and life of control equipment where frequent operations, complex systems, and continuous processes are required or atmospheric problems exist.

These new G-E systems utilize static-magnetic and solid-state devices to perform a variety of control functions normally accomplished by contact-making devices. Static switching systems consist of varied combinations of seven basic units: an isolation switch unit, two multi-purpose units, a long time-delay unit, a short time-delay unit, an "AND" unit, and an "OR" unit. These units can also be combined with static power supplies, static amplifiers, and static regulators to provide completely static control systems.

Where frequent operations are involved, static switching systems are ideal, as they have no moving parts to wear.

Where complex control functions are required, the simplified circuitry of the static switching systems makes them particularly applicable.

For continuous processes, these systems assure dependability through the use of pre-tested, industry-proved static components.

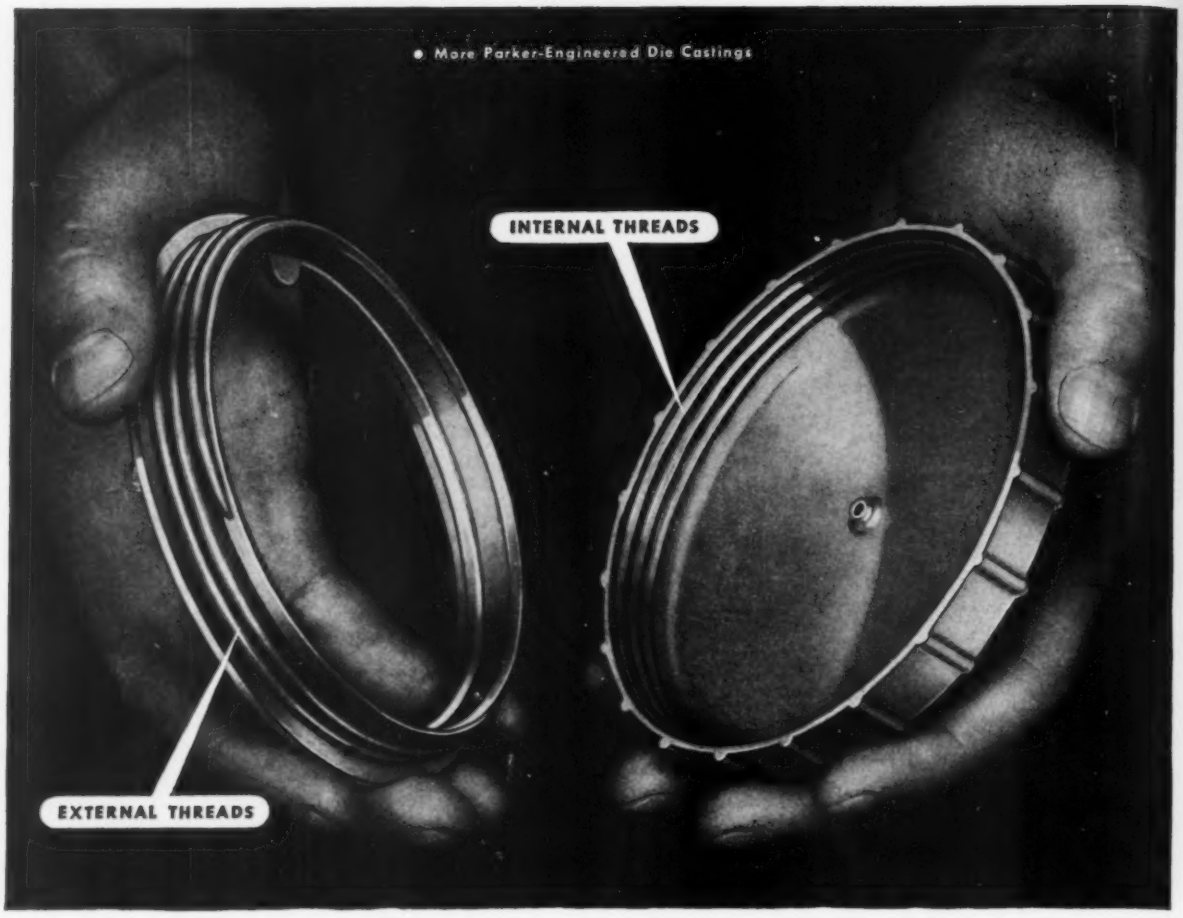
Unaffected by most atmospheric conditions, the static units are encapsulated in an inert, lightweight compound.

General Electric control engineers are ready now to help you apply the benefits of static switching systems to your machines or processes. For additional information, contact your nearest General Electric Apparatus Sales Office, or write for Bulletin GEA-6364 to Sect. 785-2, General Electric Co., Schenectady 5, New York. *Industry Control Dept., Roanoke, Virginia.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

XUM



From ONE Die: TWO Parts... THREE Savings!

PARKER SALES ENGINEERS

CHICAGO 49, Ill.
Ollie J. Berger Company • 2059 East 72 Street

CINCINNATI, Ohio
William H. Braxterman • 2174 Buck Street

DETROIT 35, Mich.
Hodgson-Geisler Co. • 18917 James Couzens

GIRARD, Penna.
Daniel F. Marsh • 35 Chestnut Street

KIRKWOOD 22, Mo.
Edward F. Higgins, Jr. • 102 West Adams Street

WILTON, Conn.
Girard L. Palmer • Belden Hill Road

SYRACUSE, N. Y.
J. C. Palmer • 712 State Tower Bldg.

BELLEFONTE, Penna.
Warren G. Olson • 420 East Linn Street

These two mating parts, including the threads, are cast simultaneously in the same die. The result—three savings:

1—One die instead of two *saves die cost*

2—Casting two parts at one time in the same die *saves production time*

3—Precision casting of the perfectly mated threads with no parting line *saves machining cost*

Together, these three savings result in a substantially lower cost per piece. Just another example of the way Parker-engineered die castings save you money.

Parker has been a leader in die casting for over 50 years—an old hand with new ideas. This skill and experience can solve problems — and save money—on *your* component parts. Just call the nearest Parker sales engineer or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure ALUMINUM and ZINC die castings
POWDERED METAL PARTS

Circle 560 on page 19

Here is an entirely new series of clutches combining, in a single compact unit, all of the PROVED advantages of MAXITORQ Floating Disc Clutch design with an exceptionally simple, powerful, and dependable electro-magnetic actuating mechanism.

As will be seen from the illustration, the new clutches use standard proved MAXITORQ Disc-Pacs, quickly and easily replaced. The electro-magnetic unit is enclosed in a stationary housing, permitting direct wiring connection. When energized, the magnetic coil acts through an armature plate and sleeve to exert pressure on the clutch discs. Pressure, however, is maintained entirely by the magnetic flux, without mechanical contact between moving and stationary parts.

This unique design permits instant, positive engagement or disengagement, with the additional possibility of precisely controlling torque for a gradual pick-up or release of load. In addition to meeting standard clutch and brake installation requirements, MAXITORQ Electric Clutches open up new possibilities in application to fully automated equipment and for remote control.

Standard sizes, single and double types, are available for either wet or dry operation to transmit up to 788 lb. ft. of torque, operating on 110V–AC rectified to 90V–DC.

Complete details sent on request. Write Dept. **MD-12.**

- **PROVED** performance.
- **COMPACT** design.
- **FLOATING** neutral . . . no drag.
- **POSITIVE** engagement.
- **STATIONARY** coil . . . no brushes.
- **NO ADJUSTMENT.**
- **WET OR DRY** operation.
- **FULL** power transmission.
- **FULL** range of sizes, types.

THE CARLYLE JOHNSON MACHINE COMPANY

MANCHESTER, CONNECTICUT

ECJ58

Circle 561 on page 19

CONTROLLED QUALITY of tubular products starts with the carbon steel and stainless steel from which they are made. Republic ELECTRUNITE® Tubing is controlled for quality from ore to finished tubing. When you specify ELECTRUNITE Tubing you are sure of getting uniform diameter, wall thickness, concentricity, strength and ductility. These characteristics back your production facilities, simplify and speed output of superior parts like the immersion heater being fabricated at right. Mail the coupon for complete information.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

REPUBLIC IRON POWDER with

Controlled dimensional factor

The Metal Powder Division of Republic Steel is now producing three types of Iron Powder, each with a variable controlled characteristic. This is called *Controlled Dimensional Factor.*

Simply stated, it means that in the presence of copper, Republic Iron Powder—depending on type—can be made to grow, shrink or remain stable within acceptable limits. The powders have been designated as Type S for shrinkage, Type G for growth, Type N for normal.

Think what this means to you as a producer or designer of iron powder parts. For example, suppose your dies have become oversize through wear. By using Type S powder, with a controlled shrinkage factor, you can continue to use those dies and still produce parts to specified tolerances.

Controlled Dimensional Factor is exclusive with Republic and the Republic production process. CDF is an addition to the excellent Republic chemistry. CDF powders are also available with apparent density ranges of 2.3 to 2.5.

For engineering service or more information on how CDF can be applied to your production of iron powder parts, send the coupon.

←
CONTROLLED PHYSICAL PROPERTIES and the cold finishing process performed on Republic Cold Drawn Steels provide dependability and economy in the manufacture of hinge pins and pivot ends on the Sherman Digger. Republic Cold Drawn Steels give these parts higher strength, greater hardness and a bright, smooth finish. They also provide top ratings on feeds and speeds, long tool life, freedom from abrasion and high product quality. Available in all carbon, alloy and stainless analyses.

→
CONTROL COSTS on your stamped and drawn parts by using the top-notch production facilities of Republic's Pressed Steel Division. This truck pedal shaft bracket is one of a wide variety of steel parts mass-produced for large-volume manufacturers. Large or small, we handle them all. Your savings in handling, inventories, labor and overhead are reflected in reduced cost per piece. Booklet 681 describes the entire operation. Send the coupon.

STEEL
and Steel Products

REPUBLIC STEEL CORPORATION
Dept. C-2217-A
3130 East 45th Street
Cleveland 27, Ohio

Send more information on:
☐ Iron Powder
☐ Cold Finished Steels
☐ ELECTRUNITE Tubing
☐ Stampings

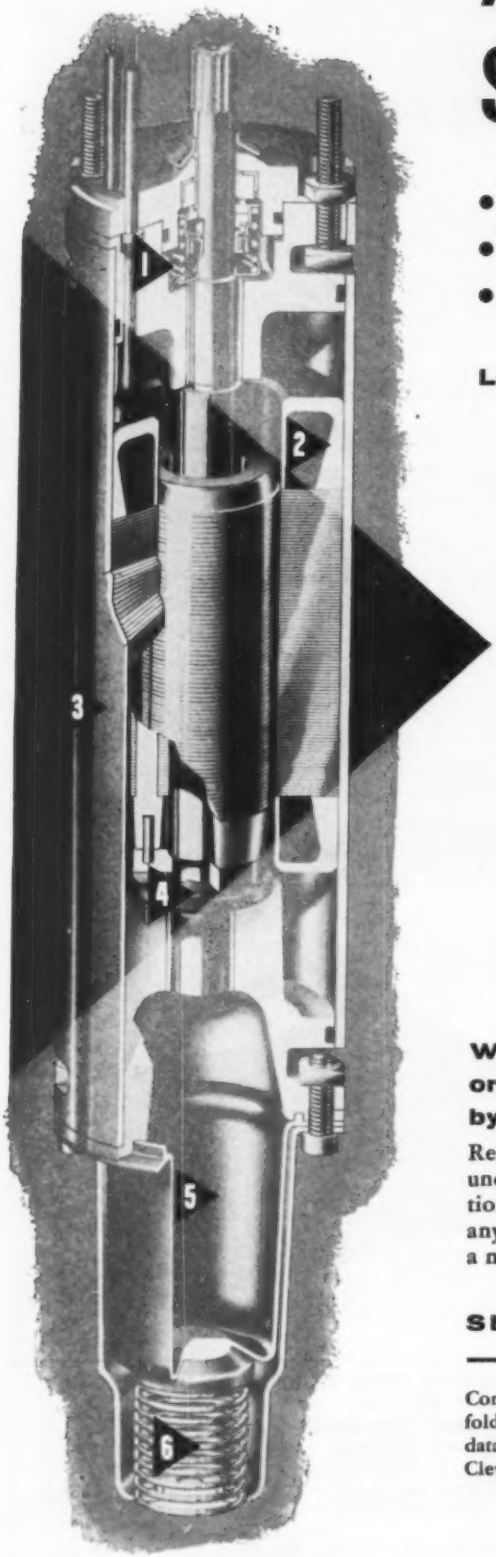
Name_____ Title_____
Company_____
Address_____
City_____ Zone____ State_____

Circle 562 on page 19

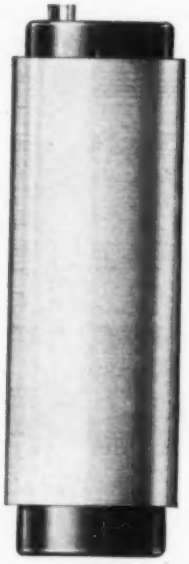
Announcing a *CUSTOMIZED*

SUBMERSIBLE MOTOR

- **that fits in a small-diameter casing**
- **that gives you high output**
- **that runs in water, oil or other fluids**



Look at typical features of a J&H Underwater Motor



1 *Rotary Seal*—Ceramic and graphitar faces, carefully lapped to insure against entry of water and contaminants.

2 *Encapsulated Windings*—A special J&H epoxy compound is used for "potting." Epoxy has exceptional heat conductivity and does not buckle or swell under many abnormal conditions. "Potting" prevents winding failure, even if water enters motor. In fact, motor will operate as water-filled unit.

3 *Corrosion-resistant Epoxy Paint Finish.*

4 *Segmented Tilting-shoe Self-aligning Thrust Assembly*—Ample reserve thrust carrying capacity is provided. Faces accurately lapped for long wear.

5 *Oil-filled Motor*—A large reservoir of oil provides additional dielectric strength, insures longer seal and bearing life, protection against corrosion.

6 *Controlled Pressure System*—Diaphragm and spring assembly insures an internal pressure sufficient to prevent infiltration by external contaminants, which could occur with normal seal wear.

● *L/D Ratio To Suit*—Length/diameter ratio can be varied to fit casing, tank, pipeline or other designated location.

Whether you're pumping water, crude oil, gasoline or other fluids, your motor need can be met quickly by Jack & Heintz!

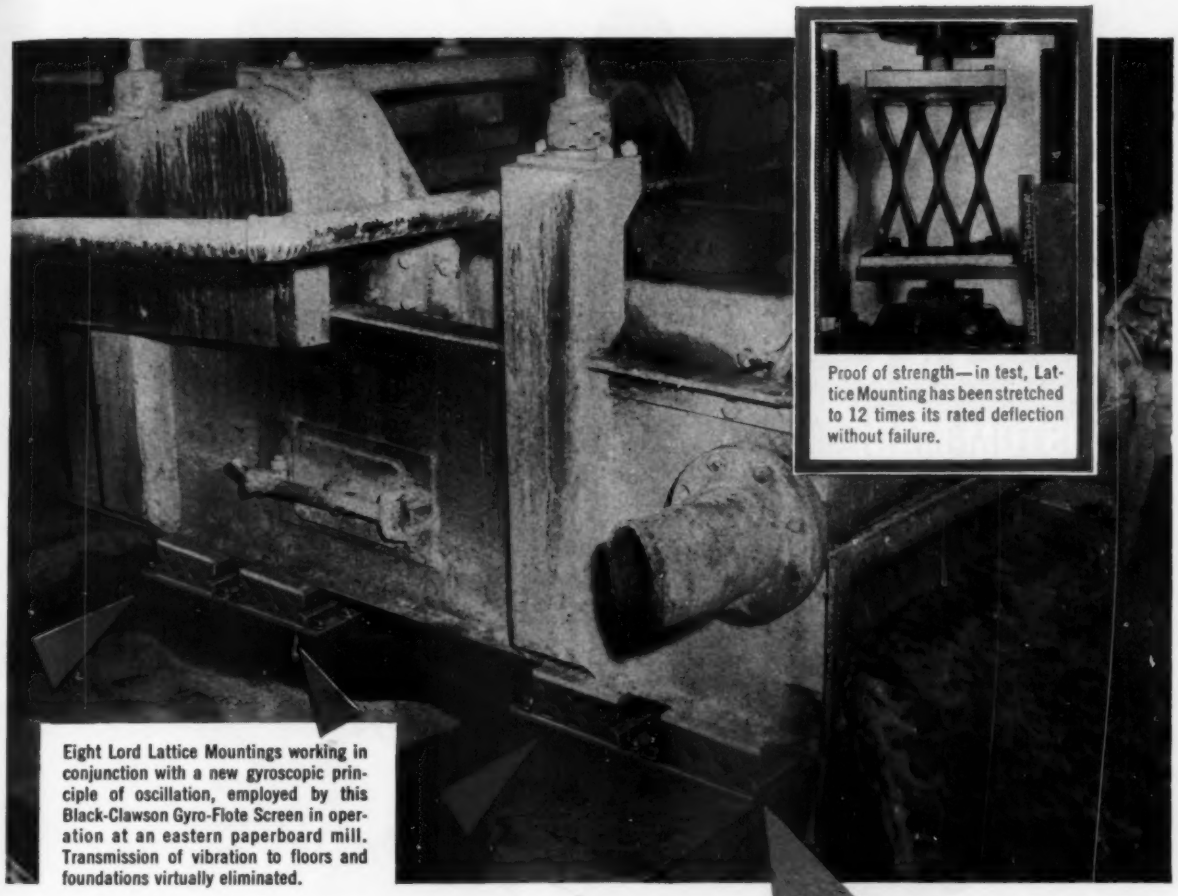
Retaining the size flexibility and long service life features of the underwater motors, J&H designers have already developed modifications for operation in crude oil, gasoline and other fluids. Customizing any of the proved basic designs to meet your specific needs is only a matter of defining your service and dimensional requirements.

SEND FOR DATA TODAY

Confer with J&H motor specialists or write for folder which gives rating and performance data: Jack & Heintz, Inc., 17626 Broadway, Cleveland 1, Ohio.

©1956 by Jack & Heintz, Inc.

JACK & HEINTZ ***CUSTOMIZED*** ELECTRIC MOTORS



Proof of strength—in test, Lattice Mounting has been stretched to 12 times its rated deflection without failure.

Eight Lord Lattice Mountings working in conjunction with a new gyroscopic principle of oscillation, employed by this Black-Clawson Gyro-Flote Screen in operation at an eastern paperboard mill. Transmission of vibration to floors and foundations virtually eliminated.

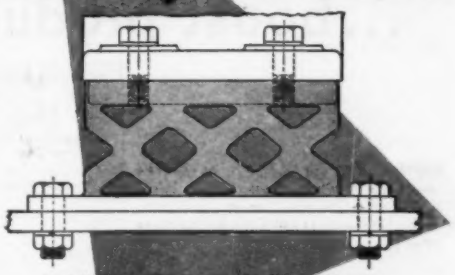
how to isolate heavy-duty machinery vibrations

LORD LATTICE MOUNTINGS PROVIDE FLEXIBLE SUPPORT—DAMPEN LOW FREQUENCY, HIGH AMPLITUDE VIBRATIONS

Efficiency-destroying machine noise and vibration can be effectively reduced by using LORD Lattice Mountings. Placed under vibrating machinery, they absorb intermittent or continuous pounding, protect performance. Installation is a simple bolting operation using tapped holes in the upper plate and through holes in the lower plate of the unit.

The patented lattice design of the flexing element, perfected by LORD research and engineering, provides soft spring rate characteristics in all directions with good horizontal stability. This element is permanently bonded to steel plates, forming a simple, one-piece unit that *never* requires maintenance.

LORD Lattice Mountings are available in load ratings from 250 to 3,000 pounds per mounting. A complete description is contained in Bulletin No. 701. For your copy, or other information, contact your nearest LORD Field Engineer or write the Home Office, Erie, Pennsylvania.



Installation diagram shows how Lattice Mountings provide a flexible but rugged base for heavy plant equipment. Installation of long-lasting mountings is easy and quick.

Lord Lattice Mountings are covered by U. S. Patent Nos. 2322193 and RE22280.

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD
BONDED RUBBER

designers and producers of bonded rubber products since 1924

ATLANTA, GEORGIA - CEdar 7-1123
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DAYTON, OHIO - Michigan 8871
DETROIT, MICH. - TRinity 4-2060
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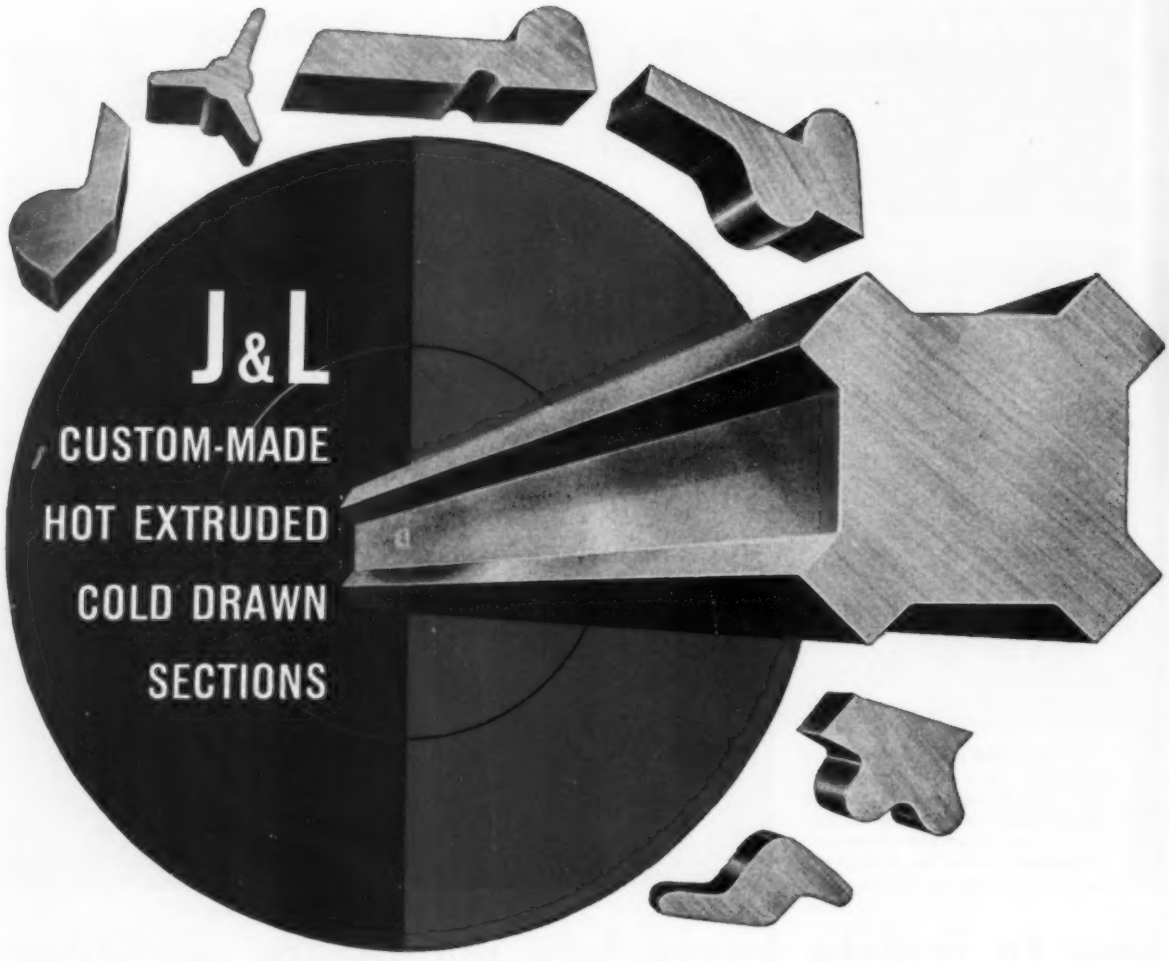
"In Canada—Railway & Power Engineering Corporation Limited"



...boost production, cut over-all costs

WRITE TODAY for your copy of this free new booklet which gives detailed information about the many money- and time-saving advantages J&L Extruded Sections offer you.

Jones & Laughlin Steel Corporation
3 Gateway Center, Dept. 410
Pittsburgh 30, Pa.

Please send me your new Booklet on Extruded Sections.

Name_____

Title_____

Company_____

Street_____

City_____

Zone_____ State_____

J&L STEEL

Progressive industry is today utilizing J&L's Custom-Made, Hot Extruded Cold Drawn Steel Sections to:

1. **Eliminate time and costs** in machining and finishing operations
2. **Reduce scrap losses** practically to the zero point
3. **Eliminate the cost of castings and forgings** of intricate sections requiring considerable machining
4. **Reduce inventories** due to quick availability of extruded sections from the J&L plant

These sections can be extruded and cold drawn to the exact specifications of the parts you require—in any quantity you specify. Even the production of a single extrusion can be economical. Obtainable in a wide range of material grades, J&L Extruded Sections can be produced in a large variety of shape profiles—within limits of a design which can be inscribed within a two-inch circle. Many shapes that cannot be hot rolled are practical for the extrusion process.

The mechanical properties of J&L Extruded Sections are equal to or superior to those obtainable from equivalent grades conventionally cold drawn. Cold drawn tolerances are accurately maintained. The excellent surfaces of these Extruded Sections require little—if any—finishing operations.

Send us your inquiry for prompt and efficient J&L service.

Jones & Laughlin
STEEL CORPORATION · PITTSBURGH

Circle 565 on page 19

NOW

a new STEAM valve with all the Rockwood Ball Valve advantages!

The new Rockwood Bronze Ball Valve for use with steam offers you many unusual benefits.

It Handles up to 125 Pounds of Steam per square inch and 350°F, with ease.

It's Leakproof — even after continued use Rockwood Steam Ball Valves stay dry.

It Opens and Closes Quickly — only a quarter turn is needed to open or close Rockwood Ball Valves.

It Has Longer Wear-Resistance — chrome-plated bronze ball withstands abrasion, scratching and pitting.

Rockwood's new Ball Valve for use with steam comes in pipe sizes from ⅜" up to 2". Send coupon for full information and data. Distributors in all principal industrial areas.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
1227 Harlow Street
Worcester 5, Mass.

Send me illustrated folder on Rockwood's new Ball Valve for use with steam.

Name.....

Title.....

Company.....

City.....Zone..State.....

Circle 566 on page 19

AMPCO — ONE-SOURCE SERVICE FROM RAW MATERIAL TO FINISHED PRODUCT

Your Ampco field engineer has

no axe to grind

—when it comes to copper-base alloys

Ampco supplies them all — and in any form of production

What does an alloy have to do for you? Resist wear, corrosion, impact, fatigue? Provide excellent bearing qualities? Retain physical characteristics at temperatures from 600°F down to –400°F?

Should it be sand-cast, centrifugally-cast, shell-molded, precision-cast, forged, fabricated, or extruded? Sheet or plate?

Whatever your design requires, your Ampco field engineer can help you . . .

1. Select the best alloy, from more than 100 Ampco copper-base alloys.
2. Select the best, most economical form of production.

Call in your Ampco field engineer. And write for Bulletin 33.

Metal for 4,000-pound casting being poured into vertical-spindle centrifugal-casting machine. Ampco makes centrifugal castings in sizes up to five tons.

Ampco's one-source service includes production-run machining of Ampco copper-base alloys to the quality standards of the aircraft industry.

Difficult coring problems are solved every day in Ampco's modern sand foundry. Ampco produces sand castings in any size up to 14,000 pounds.

AMPCO®

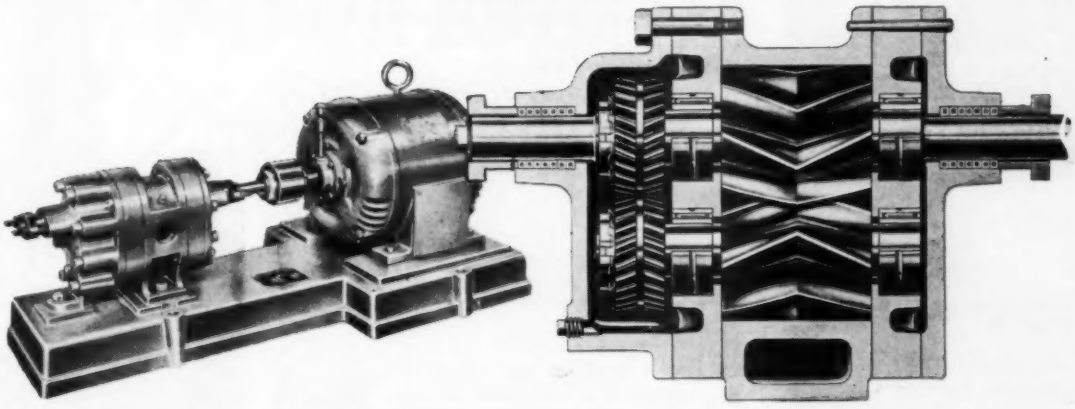
THE METAL WITHOUT AN EQUAL

AMPCO METAL, INC. Dept. MD-12, Milwaukee 46, Wisconsin • West Coast Plant: Burbank, California

ORANGE *Cage Type* NEEDLE BEARINGS

meet strict design and operating requirements

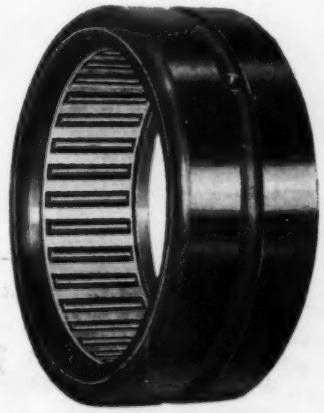
in *Sier-Bath* "Gearex"® Pumps



Sier-Bath "Gearex" Pumps (Internal Bearing Type) handle oils and lubricating materials from thin to heavy viscosities, in volumes up to 550 gpm. and pressures to 250 psi. "Gearex" Pumps are distinguished for compactness and high capacity—cool, quiet, vibration-less operation—dependability under severest 24-hour-a-day running.

Cutaway shows 4 Orange Cage Type Needle Bearings mounted on shafts of timing gears and double helical rotors. All parts and clearances are built to close tolerance and must be maintained through years of operation. The Orange cage-type bearings eliminate possibility of roller skewing—run smoothly, quietly—carry the loads in very small space—have been used successfully for eight years in this installation.

Non-skewing rollers – high capacity – small space provide answer to many bearing design problems



Don't lose the opportunity to compact your designs with the high load-to-space ratio of needle bearings because of specific or unusual operating conditions.

The unique advantages of Orange Cage Type Needle Bearings have broadened the use of needle bearings—opened many applications hitherto unsuited to conventional types.

With the Orange cage design, rollers are permanently aligned. The rollers can not skew. True running is assured at relatively high speeds and in any position—horizontal, vertical, tilted or overhung mountings. They are less affected by misaligned mounting or uneven loading. Operation is extremely quiet, even and trouble-free.

Standard sizes from ½" to 8" shaft diameters, with stocks and engineering service in all leading industrial centers. Write for 40-page Engineering Manual M-56 showing details and dimensions.

ORANGE ROLLER BEARINGS

ORANGE ROLLER BEARING CO., Inc.
556 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings
Journal Roller Bearings — Thrust Roller Bearings
Cam Followers

Circle 568 on page 19

Guarantee TOP Performance and Maximum Life!

Specify THESE TOP QUALITY FEATURES...

(Standard on Miller Cylinders at no extra cost)

Specify CASE HARDENED CHROME PLATED PISTON RODS
On all Air and Hydraulic Cylinders

Benefits To You

CASE-HARDENED Piston Rods (52-54 Rockwell "C") provide practically complete protection against damage from hammer blows, wrench-dropping, mishandling, and similar occurrences. ***Available from Miller at no extra cost.***

The HARD CHROME PLATING over the case-hardened rods protects against scratch-damage and rust. ***Available from Miller at no extra cost.***

Specify "TEFLON" WIPERS
On all Air and Hydraulic Cylinders

Benefits To You

"TEFLON" Rod Wipers and "TEFLON" Hydraulic Piston Rod Seals withstand temperatures from—100°F. to plus 500°F. They are impervious to practically all known chemicals, including the fire-resistant, special, and standard hydraulic fluids in current use. ***Available from Miller at no extra cost.***

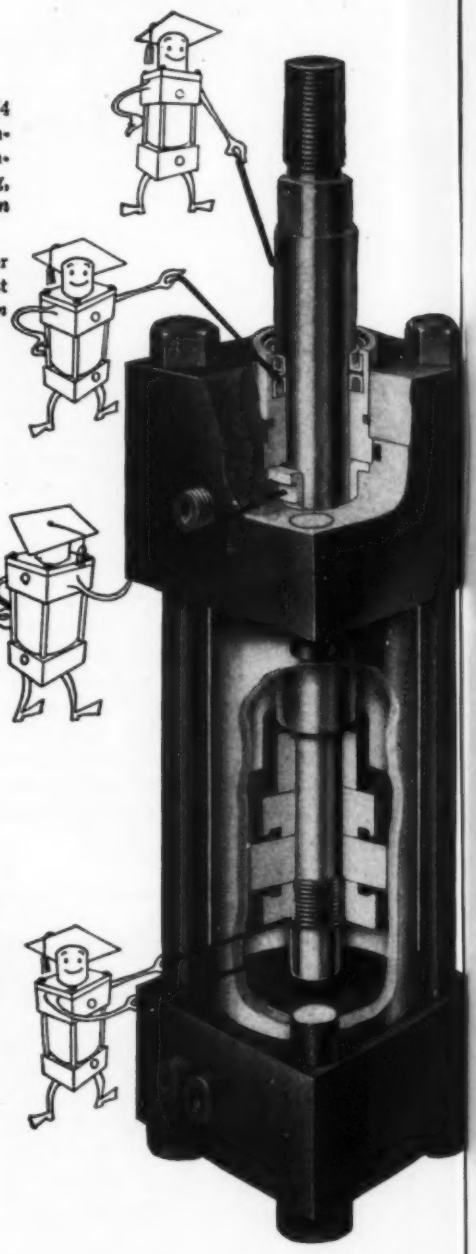
Specify TEFLON HYDRAULIC ROD SEALS
On all Hydraulic Cylinders

Specify RUST RESISTANT SURFACES
On all Air and Hydraulic Cylinders

Benefits To You

Highest quality Black Ferric Oxide Finish provides rust protection in air cylinder operation and on all cylinders during shipping and installation.

Cylinder heads, caps, mountings, pistons, followers, tie rods, and the unplated portions of the piston rods have this finish ***at no extra cost on all Miller cylinders.*** (This finish not recommended for water service)



You may wish to route this entire page to the proper department in your company, by using this handy form. Additional copies on request. →

To (Dept.)_____

"On all our future cylinder requirements, please specify the above quality features."

Signed_____

Title_____

NOTE. On all Miller Hydraulic Piston Seals: Leather Cup Seals are *standard*, Piston Ring Seals are optional *at no extra cost*, and "Teflon" Cup Seals are available *at extra cost.*

Member of the National Fluid Power Association

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • TOLEDO • CINCINNATI • COLUMBUS
PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY
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FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE
KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE
DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • ATLANTA
TORONTO, CANADA and OTHER AREAS

Circle 569 on page 19

MILLER FLUID POWER DIVISION FLICK-REEDY CORP.

2006 N. Hawthorne Ave., Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

Another new development using

B.F.Goodrich Chemical *raw materials*

HYCAR AMERICAN RUBBER CAN BE TAILORED TO YOUR REQUIREMENTS

If this is your problem:

You need a flexible material that is highly resistant to aromatic fuels, oils and solvent. The answer is Hycar 1041, a high acrylonitrile copolymer rubber—used in oil well parts, fuel cell liners, fuel hose, gaskets, O-rings, cements and adhesives. —**Hycar** 1041

Your product needs to stand up in the presence of water, while also offering good oil resistance. Hycar 1042, a medium acrylonitrile copolymer, gives this combination—extremely useful for shoe soles, kitchen mats, sink topping and printing rolls. —**Hycar** 1042

Or you must have a rubber that retains many of these other properties even at low temperatures. Hycar 1043 is a medium low acrylonitrile copolymer meeting these requirements, and easy to process. —**Hycar** 1043

If low temperatures make your problem critical, Hycar 1014 may be the answer. It's a low acrylonitrile copolymer especially designed to emphasize this property. —**Hycar** 1014

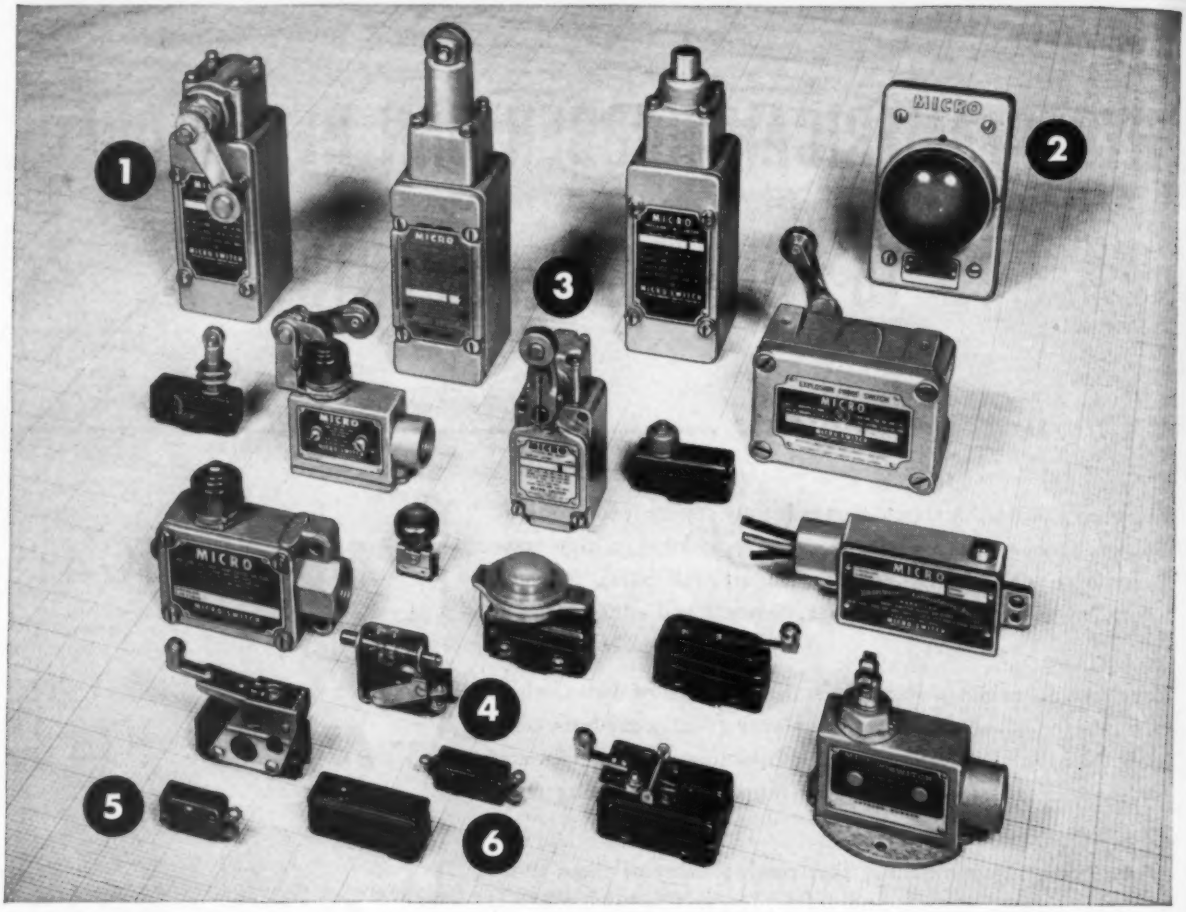
These are but a few of the many Hycar American rubbers that are tailored to meet specific requirements. Literature is available listing the properties of standard materials. For copies write Dept. EJ-6, B. F. Goodrich Chemical Company, 3135 Euclid Ave., Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ont.

Hycar Reg. U.S. Pat. Off.
American Rubber

B.F.Goodrich **GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors**

MICRO precision switches

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN



MICRO SWITCH Precision Switches meet the WIDEST RANGE of product design applications

MICRO SWITCH precision switches —a few of which are illustrated —are the switching mainstay of some of the most complex devices used in industry. They are important components in almost every type of electrically-operated equipment—from delicate instruments to massive machine tools.

Product designers know from experience that they can count on—

MICRO SWITCH Quality

From raw materials to finished product, MICRO SWITCH precision switches are laboratory tested and quality-controlled at every step of manufacture. Absolute reliability and uniformity of performance of MICRO SWITCH products is assured.

MICRO SWITCH Service

Field Engineering Service, thoroughly familiar with every type of switching problem, is readily available at branch offices in key cities everywhere.

MICRO SWITCH Development

If an application requires an entirely new switch, MICRO SWITCH Engineering Service will cooperate with you in its development and manufacture.

MICRO SWITCH Savings

Precise operation, long-life dependability and freedom from maintenance of MICRO SWITCH products result in substantial savings of time and money.

...have uses unlimited

1 RUGGED CONSTRUCTION PLUS PRECISE SWITCHING

This Type "ML" heavy-duty limit switch is enclosed within a sturdy aluminum housing, which protects the precision switching unit. The housing also provides for convenient mounting and permits conduit type wiring. Both single and two-circuit switching units are available. Choice of three different actuators—adjustable roller arm, plunger and roller-plunger types.

(Send for Catalog 83)

2 HAND SWITCH FOR POWER EQUIPMENT

This heavy-duty push button hand switch is used on punch presses and other types of hand operated power equipment. The large phenolic button operates through a sturdy aluminum cover. The switch has two double break circuits—one normally open and one normally closed. One set of contacts breaks before the other set makes.

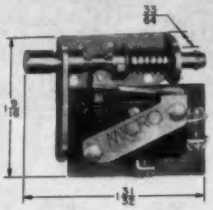
(Send for Catalog 83)

3 SMALL 2-CIRCUIT LIMIT SWITCH

MICRO SWITCH Type "LS" is a small, sealed two-circuit limit switch for use as a control of two independent circuits. Its sealed construction, high electrical capacity and features of adjustability suit it to all types of industrial applications where space limitation is an important factor in switch selection.

(Send for Catalog 83)

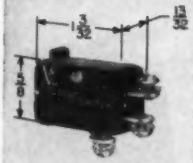
4 SAFETY SWITCH DEVICE FOR HAZARDOUS EQUIPMENT



A MICRO SWITCH door interlock switch assembly for use as a safety device on hazardous equipment. The switch automatically cuts off the power when the service door is open, enabling personnel to test or repair equipment in complete safety. Assembly shown uses a MICRO SWITCH "V3" single-pole double-throw switch.

(Send for Catalog 101)

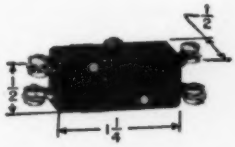
5 SMALL SWITCH— BIG CAPACITY



MICRO SWITCH "V3" switches have the highest electrical capacity for their size of any switches available. They meet exacting demands of designers for an extremely small switch with no sacrifice of quality. "V3" switches are available in a wide variety of terminal designs, contact arrangements and operating characteristics. Special switch case materials may be provided to meet requirements.

(Send for Catalog 74)

6 TWO-CIRCUIT DOUBLE-BREAK SWITCH



Keeping size and weight to a minimum, this MICRO SWITCH Type "TB" switch allows flexibility and simplicity of circuit design. A snap-action spring provides quick make and break of both contacts in each double-break circuit. Switches are available with either screw or solder terminals.

(Send for Catalog 62)

MICRO SWITCH, a division of Honeywell, is a pioneer in the manufacture of precision snap-action switches

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

XUM

2 OPERATIONS 1 MOTION

Tap and Fasten Simultaneously with
EATON-RELIANCE
Thread-Cutting Springtites and Sems

Time expended and cost are both high in any production operation where metal must be tapped for bolt or screw type assembly. By eliminating the tapping operation, both of these factors can be reduced and resulting savings will be reflected immediately in the end cost of the product.

Eaton-Reliance Thread-Cutting Springtites and Sems have been designed specifically to give production men the advantage of accomplishing two operations with one motion. These fasteners tap and fasten at the same time.

In addition to the time and cost saving advantages, Thread-Cutting Springtites and Sems assure a tightly fastened assembly. As threads are cut, the screws are seated firmly without allowing a chance for mismating or stripping. An added plus is the preassembled Spring Washer, properly engineered to maintain constant tension. Put these fasteners to work in your assembly operation NOW.

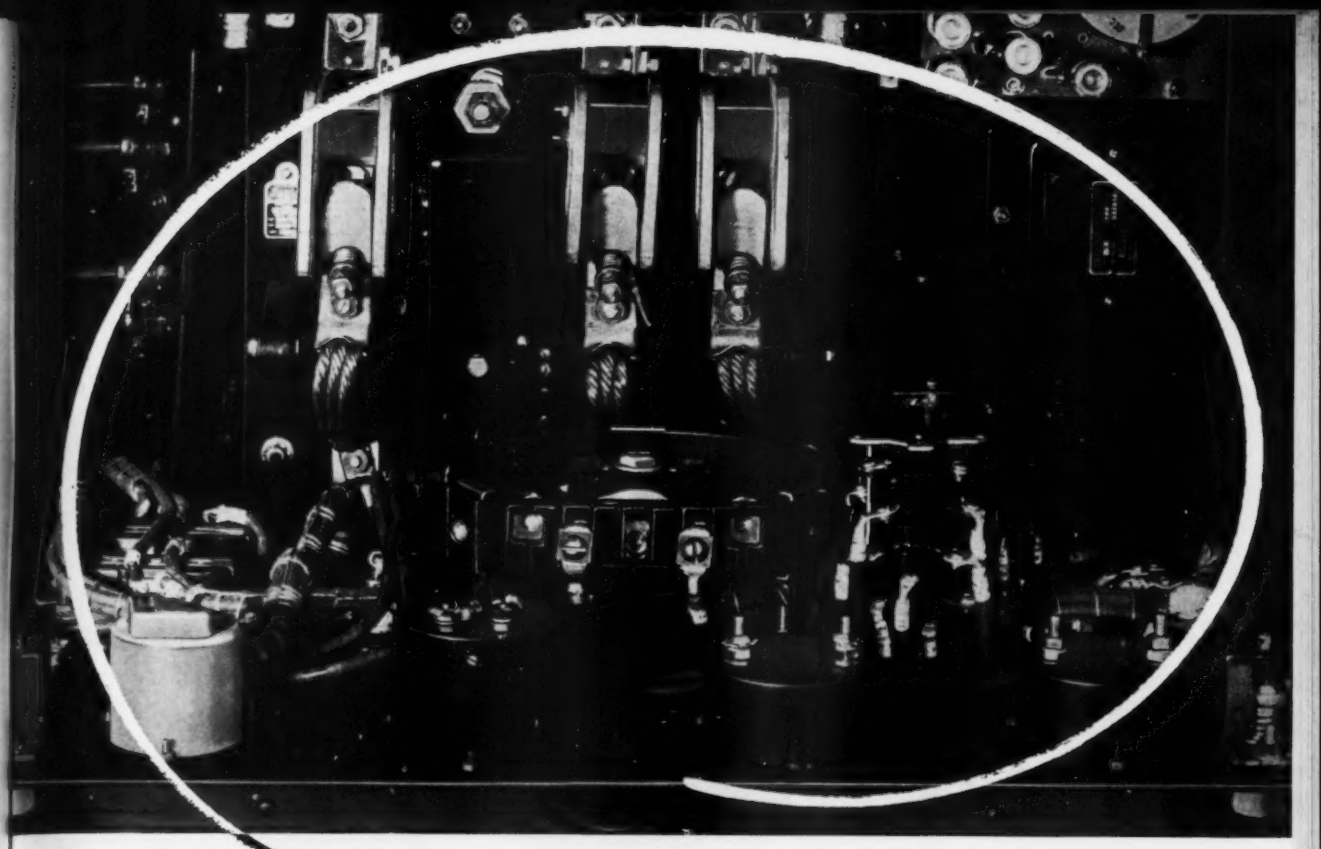
Write for a visit from one of our fastening engineers or send for your free copy of Engineering Bulletin S-49A today.

EATON

RELIANCE DIVISION
MANUFACTURING COMPANY
506 CHARLES AVENUE • MASSILLON, OHIO

SALES OFFICES: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Montreal

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers



THIS CONTACTOR ... FITS COMPACTLY IN THE BACK OF THIS PANEL

ASCO Contactor meets Army specs...

compactness, remote control & dependability

To meet the rugged tasks assigned by Army Engineers to a portable, all purpose generator, it must be compact, versatile and dependable. And that is why International Fermont has specified ASCO Contactors on its new 30 KW generator.

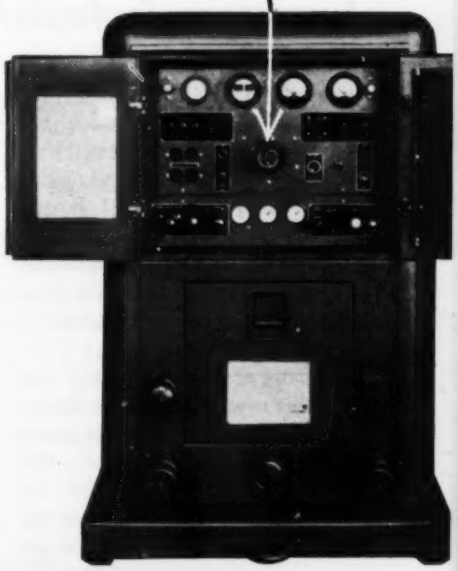
Taking up appreciably less space than is normally required by a circuit breaker, the ASCO 3-pole A-C contactor in this installation is connected between the generator and the load. A push button located on the front panel provides convenient remote control of the contactor. The contactor itself is controlled by an overload relay and must interrupt all load currents from a fault current to a short circuit.

ASCO silver alloy contact design, edgewise wound copper blowout coils, arc shields, powerful bipolar magnet and rigid construction of all parts, insure dependable operation. These features aided International Fermont in meeting rigid Army specifications which call for:

• 208 amperes per pole contact rating • 600 volts A-C maximum • undervoltage release at not less than 48 volts nor more than 84 volts • operating coil 120V — 60 cycles • operation in ambient temperature ranges — 65°F to 125°F.

Write for catalog data on ASCO Contactors: A-C and D-C, normally closed, normally open and double throw, also special applications for sign flashing, street lighting and heater control panels.

Important announcement . . . *new ASCO plant now being built in Florham Park, N. J., will double production capacity and greatly extend the range of our research, product development and services.*



AUTOMATIC TRANSFER SWITCHES
SOLENOID VALVES • ELECTROMAGNETIC CONTROL

Automatic Switch Co.

387 Lakeside Avenue, Orange, N. J. • ORange 2-5300

ASCO

Circle 573 on page 19

XUM

Twin Disc's new SP-321 PTO

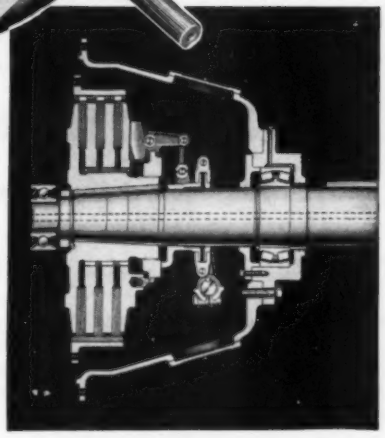
meets increased power requirements of modern industrial engines

Increased rpm. . . . increased hp output—that's the trend among industrial engine manufacturers. And that's where Twin Disc comes into the picture with its new SP-321 Power Take-Off—a friction clutch designed to meet the increased power transmission requirements of today's higher speed, higher horsepower industrial engines.

Unusually compact for its high capacity, this new PTO can handle up to 6730 lbs.-ft. of torque and transmit up to 602 hp at 1550 rpm. It's available with a standard SAE No. 00 flywheel housing adapter to meet the widest range of industrial power units in its hp and rpm ratings.

Other features include a triple driving-plate construction to provide ample friction surfaces to withstand excessive heat . . . a pilot bearing with double-width bearing race for greater lubrication retention and long life . . . and a spherical roller bearing at the clutch output shaft for greater overload and side-pull capacity.

The new SP-321 Power Take-Off —along with the recently announced SP-318 and SP-314—makes the Twin Disc line of heavy-duty friction power take-offs *the broadest, most complete line available.* For full information, write Twin Disc Clutch Company, Racine, Wisconsin. Request *new* Bulletin 308.



Twin Disc's new SP Power Take-Offs feature: counter-balanced engaging linkage; positive-type clutch engagement; pilot bearing with double grease shield; clutch plates with maximum friction area; spherical roller bearing; heavy-duty, oversize output shaft; easily adjusted clutch through pin and adjusting ring.

TWIN DISC

TWIN DISC

Friction Clutches and Fluid Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

MACHINE DESIGN
DECEMBER 13,1956

Time for Creative Effort

WHAT engineer has not griped at the amount of time he must spend, at the expense of creative effort, just reading and writing on the job? Yet correspondence, memos and reports are here to stay, and much of their handling cannot be delegated by the engineer to an aide, however competent.

It's a curious anomaly that many engineers who may be highly conscious of machine efficiencies and production efficiencies are nevertheless quite inefficient personally. In the areas of reading and writing there is often room for vast improvement. Fortunately the means for effecting improvements are available to those willing to shake off old habits.

Take reading. The average professional or business man reads about 300 words a minute. But well-known techniques and aids to faster reading can double or treble that rate in a normal person with no loss in comprehension.

Faster "writing" offers even more spectacular savings. An educated person can write legibly 30 to 35 words per minute. But he can speak understandably four or fives times as fast. A thousand-word report (which isn't long as reports go) might require half an hour just to put the words down in longhand. Speaking the same words into a dictating machine need take only seven minutes. The extra time required to write rather than to speak adds no value to the report. And the company has to pay an engineer's salary for 23 minutes of clerical work.

How "writing" efficiency can be improved by effective use of dictating equipment is explained in Al Baxter's article beginning overleaf. To management such techniques can mean better utilization of engineering manpower. To the engineer they can mean more time for creative effort and better opportunity for advancement in his profession.

Colin Carmichael

EDITOR

XUM

By A. N. Baxter
Mechanical Engineer, Los Angeles

Using Dictation Equipment

INCREASING complexity of the technical side of engineering makes communication among engineers and within departments and divisions increasingly important. Since communication is an essential, though nontechnical, aspect of engineering, it seems only logical that an attempt should be made to apply the very latest and most efficient of techniques to effect all possible time savings as well as increase accuracy in communication.

Recording and dictation equipment properly employed can produce such results. Communication by voice may be thought of as being related to pencil and paper or shorthand dictation as the modern computer is related to the slide rule.

Advantages: Many of the advantages of machine recording of dictation which result in time and cost savings accrue from its constant availability. A stenographer cannot be expected to be constantly present to take dictation or to record a phone conversation. The machine on the other hand can be instantly available for such tasks whether during, after or before office hours and whether in or out of the office.

More efficient use of the stenographer's time also results from machine dictation, since she does not have to sit idly while the one who is dictating thinks, looks for data, answers the phone, etc. Additionally, stenographic time is saved because her other duties need not be interrupted at inconvenient times for taking dictation, and actual transcription may often be scheduled so that other duties may be most efficiently handled.

Another advantage worth mentioning is that machine-recorded dictation can be transcribed by any stenographer while shorthand systems may be modified by individual stenographers to such an extent that the dictation is decipherable only by the stenographer who recorded it. On occasion, the stenographer who records the dictation may require help from the one who did the dictating to decipher technical terms commonly encountered in engineering.

An actual cost study, Fig. 1, shows that dictation and recording equipment can pay for itself in a relatively short time. Uses not included in the study which also produced savings were:

1. Use in shop, on field trips, etc.
2. Conference and interview recording.
3. Telephone conversation recording.

Comparisons made here have been with a stenographer using shorthand. Any study of machine dictation or recording vs. long-hand writing results in an even greater disparity in favor of the machine.

Applications: It must be emphasized that recording and dictation equipment are not cure-alls

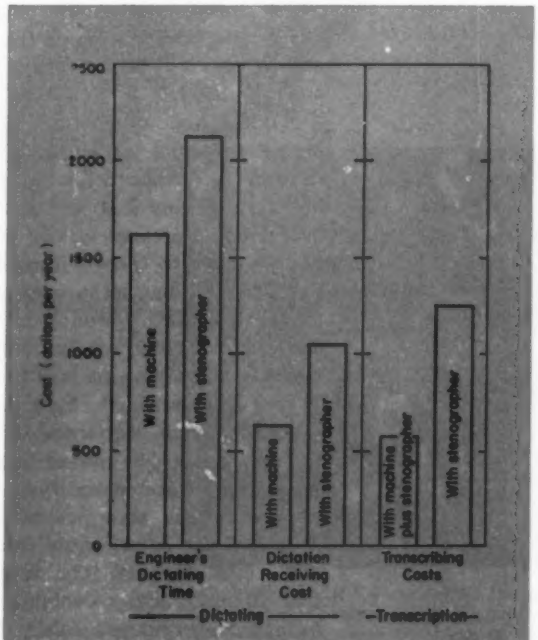


Fig. 1—Results of a cost analysis based on purchase and use of two dictation receivers and one dictation transcriber costing a total of $1200.00. Other pertinent conditions are that 1.5 hr of recording medium were used per week and equipment depreciates 50 per cent in value during the first year of use, then to zero value at the end of five years. Despite this severe depreciation, savings nearly paid for the equipment during the first year. Further analysis showed that in two years the equipment could pay for itself from savings in stenographer's wages alone; in three years from engineer's salary alone. Engineer's time cost per hour (salary plus overhead) used was $7.00.

. . . to increase engineering output

or stenographer eliminators. The recorded voice rarely goes through the machine-stenographer combination and comes out clearer or more logical. There are certain uses, Table 1, which are *naturals* for recording or dictation. In other instances, particularly when a message is extremely short, a jotted note or dictation directly to a stenographer may be more efficient.

Problems: In addition to the possible problem of selling management on the purchase of recording and dictation equipment, there are two other possible trouble sources—the stenographer and the person doing the dictation. A stenographer may complain that using dictation equipment will diminish shorthand efficiency. The solution to this is to allow shorthand to be used for as many short notes and memos as may seem feasible. Two more very legitimate protests the steno can make are against spending many successive days transcribing and having to transcribe poor dictation. Solutions to these are: (1) avoid the first and (2) learn proper dictating procedure, Table 2.

Difficulties for the person dictating are largely solved by following the aforementioned rules, Table 2. However, there are two others. First is simply the initial unfamiliarity and seeming laboriousness involved in use of the equipment. A few hours of use will eliminate "mike fright" and increase output. Second problem is possible ribbing by fellow workers. This will often be shortly followed by the nuisance of having to recover borrowed equipment.

Available Equipment: All available recording and dictating equipment may be classified as stationary, semiportable or portable. Stationary units for purposes of this discussion are considered to be any unit exceeding 20 lb in weight. Additionally, several companies sell in-plant systems which permit dictation through a telephone. Out-of-sight wiring connects the telephone to a central-

Table 1—Natural Applications of Dictation Equipment

1. Writing reports, memos, letters, daily logs, books and articles at office or home.
2. Recording telephone calls to increase accuracy and save time spent writing down information.
3. Accurately recording conferences, meetings and interviews with consultants, customers, potential employees, etc.
4. Communicating with superiors or assistants when out of town.
5. Abstracting information from short-loan material.
6. Receiving information when engineer is not at desk (automatic telephone answering equipment).
7. Quick compilation of tables and lists from raw data; data evaluation.
8. Verbal note taking while traveling, visiting or observing (field tests, shop inspections).
9. Compiling inventory lists.
10. Polling opinions of products.

Table 2—Dictation Do's and Don'ts

Before Dictation

1. Prepare a detailed outline including reminders and notes on references. Put all equations and calculations in the outline.
2. Assemble, in order, all references, charts, brochures, calculations, tables, curves, photos, oscillograph records or other material to be consulted while dictating.

During Dictation

1. State your name, the date, subject, addressee, recipients, classification, required approvals and special instructions at the beginning of the first record.
2. Identify yourself and your subject at the beginning of each succeeding record.
3. Ask the stenographer to refer to the outline when transcribing.
4. Talk freely and rapidly; don't struggle for the best word. Keep sentences short and crisp.
5. When necessary, instruct the stenographer to leave space for correct words and temporarily unknown names or dates.
6. Continually refer to the outline.
7. Spell out people's names and difficult words. Use a phonetic alphabet.
8. Enunciate clearly and distinctly. For instance, say "cylinderrzz" for cylinders.
9. Never dictate with something foreign in your mouth such as cigarettes, pipes, pencils, gum, etc.
10. Call out all punctuation (colon, period, quote, etc.) and new paragraphs.
11. Never dictate equations!
12. Talk across, not into, the microphone.
13. Try to keep voice level and mike distance fairly constant.

XUM

Table 3—Characteristics of

Manufacturer	Portability	Machine Type	Machine Cost (dollars)	Service Contract Cost (dollars/year/machine)	Machine Weight (lb)	Approximate Dimensions Width, Depth, Height (in.)	Power Requirement	Shape of Recording Medium	Initial Cost (dollars)	Recording Duration (minutes/medium)	Permanent Storage Cost	Mailability	Susceptibility to Damage During Handling	Susceptibility to Erasure During Handling	Susceptibility to Breakage During Dictation	Ease of Storage	Cross Talk, Surface Noise
Magnetic Machines																	
1	SP	C	350	22	25	15,15,8	110 v ac	Tape	2.75	15 to 120	H	PO	L	L	L	PO	N
2	SP	C	425	30	22	14,16,7	110 v ac	Tape	2.75	15 to 120	H	PO	L	L	L	PO	N
3	SP	C	200	25	12	12,10,4	110 v ac	Tape	2.75	15 to 30	H	PO	L	L	L	PO	N
4	P	C	280	N	3	8, 4,2	SCB	Tape	11.50	60	H	PO	L	L	L	PO	N
5	P	C	300	25	3	7, 4,2	SCB	Tape	9	30 to 60	H	F	L	L	L	PO	N
2	SP	C	300	—	11	12,16,3	110 v ac	Tape	2	15 to 60	H	PO	L	L	L	PO	N
6	Installation $35.00 Rental $12.50 per mo.				30	15,16,6	110 v ac	Tape	Will handle twenty messages each 28 seconds in duration.								
7	SP	DR DT C	381 375 420	25	18	11,11,6	110 v ac	Belt	0.70	15	H	E	L	H	L	F	L
8	SP	C	350	25	15	10, 6,9	110 v ac	Belt	0.80	11	H	E	L	H	L	F	L
7	SP	DR DT C	365 380 460	23	28	12, 7,12	110 v ac	Wire	20	15 to 60	H	PO	L	L	H	PO	N
9	SP	C	325	30	19	18,11,9	110 v ac	Wire	6	15 to 60	H	PO	L	L	H	PO	N
10	SP	C	250	36	28	10, 6,12	110 v ac	Wire	6	60	H	PO	L	L	H	PO	N
11	P	C	300	N	2	4, 7,2	SCB 110 v ac 6-12 v dc	Wire	6 to 23	15 to 300	H	PO	L	L	H	PO	N
12	SP	C	320	20	16	15,11,6	110 v ac	Disk	2.50	10	H	G	L	H	L	F	L
13	SP	C	220	30	12	10, 9,6	110 v ac	Disk	1.00	10	H	E	M	H	L	F	L
Embossing Machines																	
5	SP	DR DT C	360 360 450	22	13	13,10,5	110 v ac	Belt	0.04 0.08	15 or 30	L	G	H	L	L	G	M
14	SP	C	400 to 800	—	8 to 10, 4,9		SCB 110 v ac	Belt	0.17 to 0.25	90 to 240	L	E	H	L	L	G	M
15	SP	DR DT C	360	25	12	12,10,3	110 v ac	Disk	0.10	30	L	G	H	L	L	G	H
16	SP	DR DT C	375 365 425	25	17	9,12,7	110 v ac	Disk	0.025 0.05 0.09	8 15 30	L	G	H	L	L	G	H
16	SP	C	275	—	6	6,10,3	110 v ac	Disk	—	15	L	G	H	L	L	G	H
17	SP	DR DT	365 365	25	15	10,10,7	110 v ac	Disk	0.06 0.09 0.14	20 30 60	L	G	H	L	L	G	M
17	SP	C	425	25	15	10,10,7	110 v ac	Disk	0.06 0.09 0.14	20 30 60	L	G	H	L	L	G	M

Key to Manufacturers

Code No.	Trade Name	Company Name	Address
1	Memo-Tape	Technical Associates Inc.	140 W. Providencia Ave. Burbank, Calif.
2	Scribe Scribbler	Permoflux Scribe	2835 N. Kedzie Ave., Chicago 18, Ill.
3	Stenoretta	DeJur-Amsco Corp.	Long Island City, N. Y.
4	Midgetape	Mohawk Business Machines Corp.	944 Halsey St., Brooklyn 33, N. Y.
5	Dictaphone, Dictet	Dictaphone Corp.	420 Lexington Ave., New York 17, N. Y.
6	Pacific Telephone	Bell Telephone System	
7	Pierce	Pierce Dictation Systems Corp.	5900 Northwest Highway, Chicago 31, Ill.
8	Comptometer	Felt and Tarrant Mfg. Co.	1735 N. Paulina, Chicago 22, Ill.
9	Steno	Crescent Industries Inc.	5900 Touhy Ave., Chicago 31, Ill.
10	Dictascriber	The Magnetic Corp. of America	Chicago 22, Ill.
11	Minifon	Geiss-America	Chicago 45, Ill.

Available Dictation Equipment

Dictation Characteristics												Transcription Characteristics							
Adequacy of Microphone Controls	Play Back Fidelity	Physical Shock Sensitivity	Susceptibility to Accidentally Not Dictating	Recording Level Indicator	In Recording Position Indicator	End of Dictation Indicator	Ease of Record Review	Indexing System	Performance as Conference Recorder	Speed of Total Erasure	Telephone Attachment	Ease of Starting and Stopping	Ease of Locating Errors	Ease of Back Spacing	Ease of Refinding Position on Medium	Earpiece Quality	Speed Control	Tone Control	Volume Control
E	E	L	L	N	E	N	F	E	E	H	Y	G	E	G	E	F	N	Y	Y
E	E	L	M	N	G	N	F	PO	E	H	Y	G	PO	G	PO	G	N	Y	Y
F	G	L	M	N	G	N	PO	F	G	H	Y	F	PO	E	PO	E	N	Y	Y
N	PO	L	M	N	N	N	PO	PO	F	L	Y	PO	PO	PO	PO	F	N	N	Y
N	F	L	M	N	PO	N	PO	PO	PO	L	N	PO	PO	G	PO	F	N	N	Y
—	—	L	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	G	L		This is automatic telephone answering unit.								Units available from which transcriptions can be made.							
G	G	L	M	N	PO	Y	G	G	G	H	Y	G	G	E	G	G	Y	Y	Y
G	G	M	M	N	F	Y	G	F	G	H	Y	G	F	G	F	G	N	Y	Y
F	G	L	M	N	N	N	F	E	G	H	Y	G	PO	F	PO	F	N	N	Y
PO	G	L	H	Y	N	N	PO	G	G	H	Y	G	G	E	G	G	N	N	Y
PO	G	L	H	Y	N	Y	F	G	G	H	Y	G	G	G	G	G	N	Y	Y
N	F	L	M	N	PO	Y	F	PO	F	H	Y	F	PO	F	PO	G	N	N	Y
P	G	H	M	N	PO	Y	F	PO	PO	H	Y	F	F	F	F	F	N	N	Y
F	G	M	M	N	N	N	G	F	F	H	Y	G	F	PO	PO	F	N	N	Y
G	G	M	L	Y	Y	Y	G	G	G	N	Y	G	G	G	G	G	Y	Y	Y
F	F	M	M	Y	N	Y	G	F	G	N	Y	F	F	F	F	F	Y	Y	Y
F	PO	K	H	N	PO	Y	F	F	PO	N	Y	G	PO	G	PO	F	Y	Y	Y
G	F	M	L	Y	Y	Y	G	G	F	N	Y	G	E	G	G	F	Y	Y	Y
F	F	H	H	N	PO	Y	G	F	F	N	N	F	F	N	F	F	N	N	Y
G	F	M	M	Y	Y	Y	G	G	F	N	Y	G	F	G	PO	F	Y	Y	Y
G	F	M	M	Y	Y	Y	G	G	F	N	Y	G	F	G	PO	F	N	Y	Y

Key to Manufacturers

Code No.	Trade Name	Company Name	Address
12	Rex	American Dictating Co.	65 Madison Ave., New York 16, N. Y.
13	Voice-Master	Magnetic Recording Industries	30 Broad St., New York 4, N. Y.
14	Walkie Recordall	Miles Reproducer Co. Inc.	812 Broadway, New York 3, N. Y.
15	Tele-Voicewriter Ediphone Vice President	Thomas A. Edison Inc.	West Orange, N. J.
16	Sound Scriber	The SoundScriber Corp.	145 Munson, New Haven, Conn.
17	Audograph	Gray Mfg. Co.	16 Arbor St., Hartford 1, Conn.

Key To Code Letters

C = Combination Unit
DR = Dictation Receiver
DT = Dictation Transcriber
E = Excellent
F = Fair
G = Good
H = High
L = Low
M = Medium
N = No or None
P = Portable
PO = Poor
S = Stationary
SP = Semiportable
SCB = Self-Contained Batteries
Y = Yes

ly located group of recorders. Lights on the phone show which machine is available for use, and pushbuttons permit selection. An attendant at the receiving end changes the recording medium when it is filled.

Advantages of such a system are concealment of the recorders and corresponding low space requirements on the desk top of the person dictating. Disadvantages, in addition to the lack of portability, are: (1) the possibility of all recorders being in use when it is desired to dictate, (2) high cost for a small installation, (3) need for an operator at receiving end, (4) difficulty in making log or index cards, and (5) difficulty in reviewing, or playback, without special equipment.

Semiportable units are those weighing from 12 to 20 lb and occupying sufficient volume to make them inconvenient for travelling. Only real disadvantage of these units is their lack of portability. However, they can be easily moved on a typewriter table or within a building. Fidelity is usually good and these units are quite versatile.

Portable units weigh approximately 2 lb. Any weighing more than 4 lb create definite travel inconvenience. Some of these units are small enough to be carried in a coat pocket, while others are provided with camera-type carrying cases. Although these units are usually designed for operation using self-contained batteries as a power source, some may also be operable on 110 v ac or dc and from a 6 or 12 v dc source as in an automobile by using a converter to change the dc to ac. Recording media are usually difficult to mail. As compared to other types, only advantage of portable units is their portability.

Another way in which recording or dictating equipment may be classified is by function. That is, as (1) dictation receivers, (2) dictation transcribers or (3) combination units which will both receive dictation and permit transcribing. Dictation receivers do, of course, permit playback or review of what has been recorded. However, earphones or foot-actuated switch to permit convenient transcription cannot be attached to the dictation receiver.

Dictation transcribers do not permit recording. They operate with the recorded medium from a dictation receiver or a combination unit. Either hand or foot controls for speed, reversing and rapid backup are usually incorporated. Earphones may be, or are, attached to the transcriber.

Combination units offer all the features of recorder and transcriber. Of course, both operations cannot be performed simultaneously. Although cost is usually somewhat higher than single-purpose equipment, the increased versatility at a cost less than that of two single-purpose units may be well worth it. Of course, there is the possibility that the unit may be in use for transcription when it is desired to dictate or vice versa.

Other differences to be considered in dictation equipment selection are the recording system and the various recording mediums used. The two basic methods used in recording are embossing and magnetization. Embossed media may be disks, belts or cylinders. Magnetic media include wire, disks, tapes or belts.

There are certain inherent advantages and disadvantages associated with these recording systems and the recording media. Embossed cylinders, for example can be completely destroyed by rough handling and ensuing breakage. Other disadvantages of the embossing system regardless of shape of the medium include:

1. Erasure and correction during dictation not possible.
2. Fidelity losses as embossing styli wear.
3. Possibility of record surface noise, cross talk and echos.
4. Susceptibility to mechanical shock causing stylus jump.
5. Cost of stylus replacement.
6. Susceptibility to groove damage by dust as well as handling while in use and in storage.
7. Low sensitivity for conference recording.
8. Relatively short dictation interval.

There are, of course, certain advantages of the embossing system. These include:

1. Ease of mailing recording medium.
2. Low cost of permanently retained recordings.
3. Reasonably rapid location of specific bits of dictation on the medium.

It should be noted in regard to the second advantage listed that once material is transcribed, procedures and cost of permanent retention of the transcribed material are identical regardless of the recording method.

Outstanding advantages of magnetic recording are the fidelity or clarity of reproduction and instant erasibility. Typists need not anticipate or search for errors nor must they strain to hear and understand. The ability to erase and correct is also a great psychological aid to the one dictating.

Magnetic recorders are generally quite resistant to mechanical shock, an important requisite for a portable machine. Additionally, tape and wire recorders are the only types which can be made sufficiently small and light to be truly portable. Another general advantage of magnetic recorders is their sensitivity. This makes them particularly useful for such things as recording proceedings of a conference. At times this may be a disadvantage because background noises may be picked up along with dictation.

First cost of magnetic recording media is high as compared to cost of embossed media. However they may all be erased magnetically and used over and over again.

First magnetic recording medium to be developed was stainless-steel wire. Since the wire is only a few thousandths of an inch in diameter it tends to break when subjected to shock loads and temperature extremes. Although it is sometimes possible to knot the broken ends and proceed, the

knot is a point of stress concentration and is apt to cause another break to occur. Although wire reels are more difficult to mail than tape reels, belts or disks, they offer more recording time per unit volume than these other media.

Magnetic tape probably incorporates more advantages than other magnetic recording media. It is not easily damaged nor accidentally erased during handling or mailing. Dictation time may be several hours. Machines for use with magnetic tape have achieved a very high degree of development. Some of the more interesting features are: (1) speedometer type position indicator which when used with a log allows quick, easy location of a particular section, and (2) foot-operated microphone switches which leave both hands free for talking.

Magnetic belts do not offer the duration of recording time available with wire or tape. Maximum recording time is from 10 to 15 minutes. Handling and storage is more convenient than for wire or tape since the belts may be folded.

Magnetic disks are durable, reusable and easily mailed. Recording time is limited to about 15 minutes. Disadvantages of disks and associated equipment are poor portability and mechanical shock sensitivity.

Selection: To select the proper dictation equipment it is necessary to consider the requirements of a particular application carefully and match them as closely as possible with the features of available equipment. Cost is also an important consideration—not only first cost but continuing costs such as for purchase of recording media. Many of these characteristics are summarized in Table 3 for the majority of available equipment.

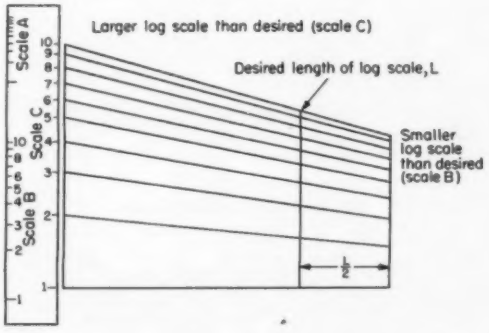
There is one more extremely important factor which probably cannot be too strongly emphasized. No matter how well requirements and characteristics are matched on paper, the equipment will not be satisfactory unless it is physically convenient to operate from the standpoint of both the individual dictating and the person transcribing. This evaluation can only be made by using the equipment. In most instances equipment can be borrowed for a trial period or perhaps rented. When equipment is rented, it may be possible to apply the rental to the purchase price if purchase is decided upon.

Tips and Techniques

Log Ruler

A special log ruler like that shown may be easily constructed and can be extremely useful in constructing special nomographic scales. To construct the rule, different decade lengths are cut from log paper and cemented to a strip of plastic or acetate. Scales may be any convenient length but lengths of 2, 4 and 6 in. have been found to be extremely useful.

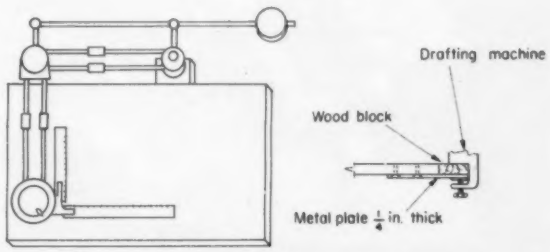
To use the scale to construct a log scale of any



length, L, the proper length, L, is first measured. Then scale B is drawn any convenient distance from L. In many cases, a distance $L/2$ will prove to be quite convenient. Guide lines are then drawn from the ends of scale B through the ends of L and extended until they converge or diverge sufficiently to fit scale A or C. Scale A or C is then drawn and corresponding graduations are then joined with those on scale B to produce the required intersections on L.—KENNETH G. LEIB, *Sylvania Electric Products Inc., Kew Gardens, N. Y.*

Drafting Board Extension

By adding a simple extension to the top of a standard drafting board for mounting a drafting machine, the entire board area may be kept free from the drawing. Details of such an extension are shown. Width of the block should be to suit the drafting machine. Thickness of the block should be equal to that of the drawing board.—WILLIAM R. BARLOW, *Muncy, Pa.*



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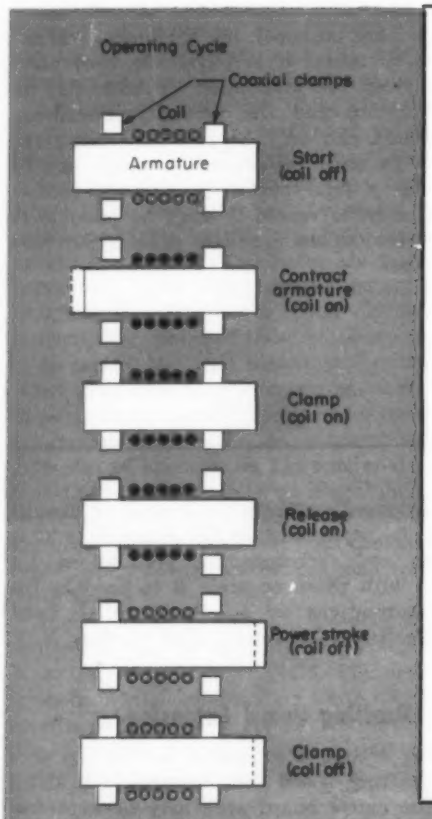
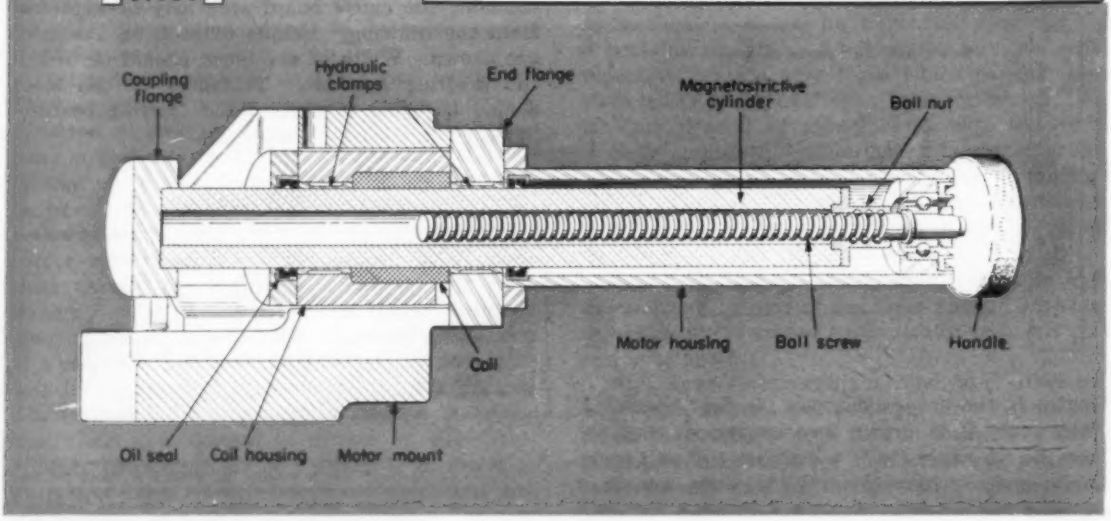
scanning the field for Ideas

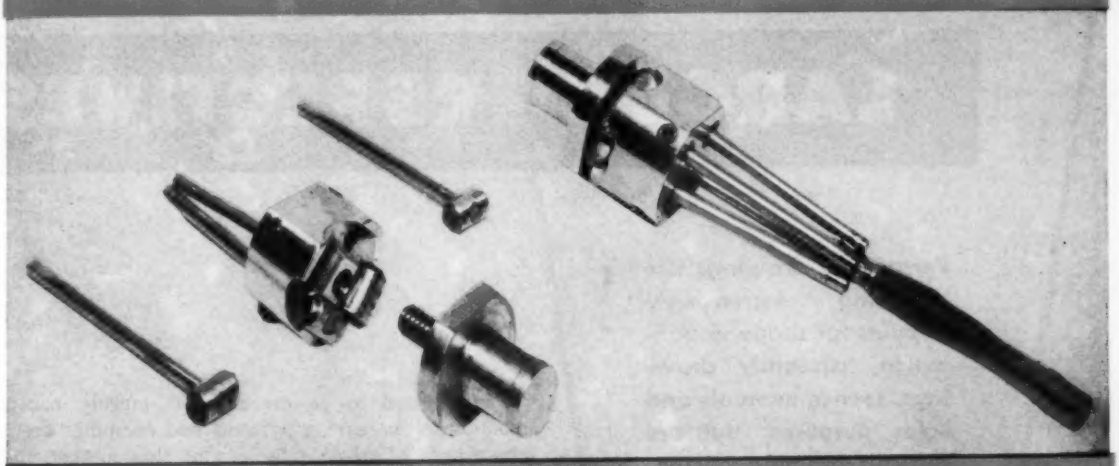


PRECISION POSITIONING of machine assemblies is accomplished without backlash in a novel electrical linear-actuator design. Developed by E. Silver and G. S. Butterworth of Airborne Instruments Lab. Inc., the actuator motor, which is tradenamed Inchworm, produces an incremental, linear stepped motion by the magnetostrictive effect.

In operation, the armature of the motor shrinks under the influence of an electromagnetic field developed by the coil. If the coil is de-energized, the armature snaps back to its original size. Direction of linear motion of the coil housing in relation to the armature is controlled by the proper sequencing of the locking action of a pair of coaxial clamps in the housing ends. Size of stepped movements in either direction depends on load, spacing of the two clamps, and amount of current in the coil.

The clamps are fluid-filled cylindrical grooves covered with a membrane that contacts the armature. When lock-up of a given clamp is desired, hydraulic fluid is applied in the groove under pressure to deform the membrane and form a friction lock with the armature.



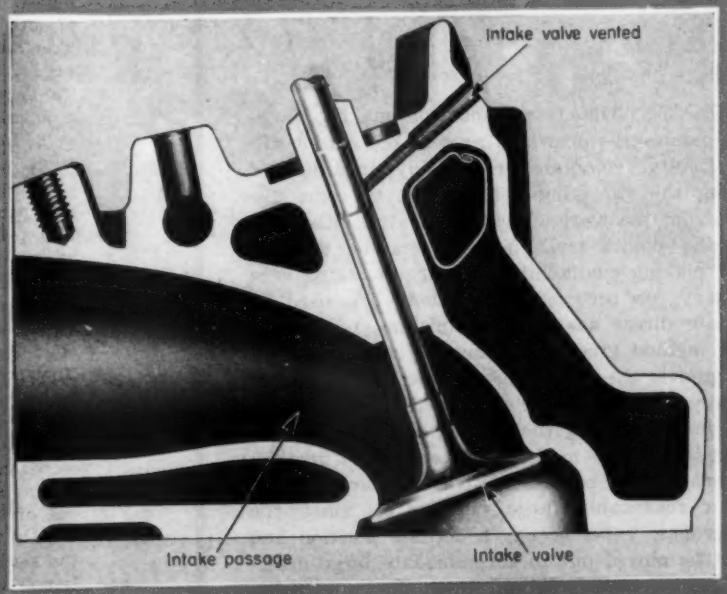


CLAMPING OF IRREGULAR SHAPES under high-temperature conditions is accomplished by a novel sample-holder construction. The design was developed by Julius Soled, Signal Corps Engineering Lab., Fort Monmouth, for holding silicon rods in an induction heater.

Set screws press against each of four tungsten fingers to lock an object in place. Radial movement of each tungsten finger is permitted by a T-bar pivot construction.

The assembly is easy to clean and the metal-to-metal contact of the components improves cooling of the clamping fingers.

VENTED VALVE CONSTRUCTION for internal combustion engines simplifies lubrication problems in vacuum environments. In 1957 Pontiac V-8 engines, atmosphere is admitted to a space between the intake valve stem and stem guide through a drilled hole in the cylinder head. Vacuum developed within the intake passage during engine operation is thus prevented from drawing lubricating oil into the combustion chamber through the clearance between the valve stem and its guide.



XUM

LARGE PERSPECTIVES

Perspective drawings are becoming increasingly popular for shape visualization, assembly drawings, service manuals and sales purposes, but are difficult and time consuming to make. This article presents a rapid and simplified method for large perspectives, utilizing a mastersheet underlay which may be reused.

By Victor Paquet, Glenn Dewey and George Charron
Division of Graphics
University of Vermont
Burlington, Vt.

CONVENTIONAL methods of making large perspective drawings present one major difficulty. To obtain a reasonably large finished drawing the vanishing points must be some distance from the work. This means that either the vanishing points must be kept on the drawing board, making availability of a large working area necessary, or involved calculations are used to eliminate direct use of the vanishing points.

The method given here has one substantial advantage over the method-of-intersections approach[1] to perspective projections. The final drawing is large in relation to the size of the construction required. In the method-of-intersections method the construction must be impossibly large to get even a reasonably large perspective, since the orthographic views occupy a definite position and cannot be moved out to accommodate large drawings. An ingenious solution, which eliminates using inaccessible points by means of scales, has been published,[2] but the scales are difficult to construct.

The method to be described is largely based upon these two earlier systems and combines their advantages. Desirable factors of this method include: need for special equipment is eliminated, work may be done on a medium-size drawing board, and very little background theory need be referred to. The computations for making the master chart are simple and fast. Very little preparatory work is necessary; only a three-view orthographic drawing on tracing paper and the master chart are required. The master chart has fixed view angles

Making the Drawing

Constructing a perspective drawing by use of the master chart is simple and fast.

1. Three views of the object are drawn on tracing paper, cut out, and taped to the master chart in their revolved, correctly oriented positions as shown.
2. Tracing paper to be used for the drawing is taped over the master chart.
3. To locate any point in the perspective, a sharp pencil is placed on the desired point in any one of the three views. The right side will be used for illustrative purposes. A straightedge is then aligned with the selected point and point *D'*.
4. The pencil is then moved to the point where the straightedge intersects scale 5.
5. The straightedge is pivoted about the pencil to align with point 1.
6. Pencil is moved to where the straightedge intersects scale 6.
7. The straightedge is pivoted about the pencil until it passes through like readings on scales 5 and 6.
8. This places the straightedge on a projector carrying the given point.
9. A similar procedure is carried out using one of the other views, and the intersection of the two projectors is a point on the perspective. As one becomes accustomed to the process, the steps become automatic and the pictorial builds up rapidly.

[1]References are tabulated at end of article.

SIMPLIFIED

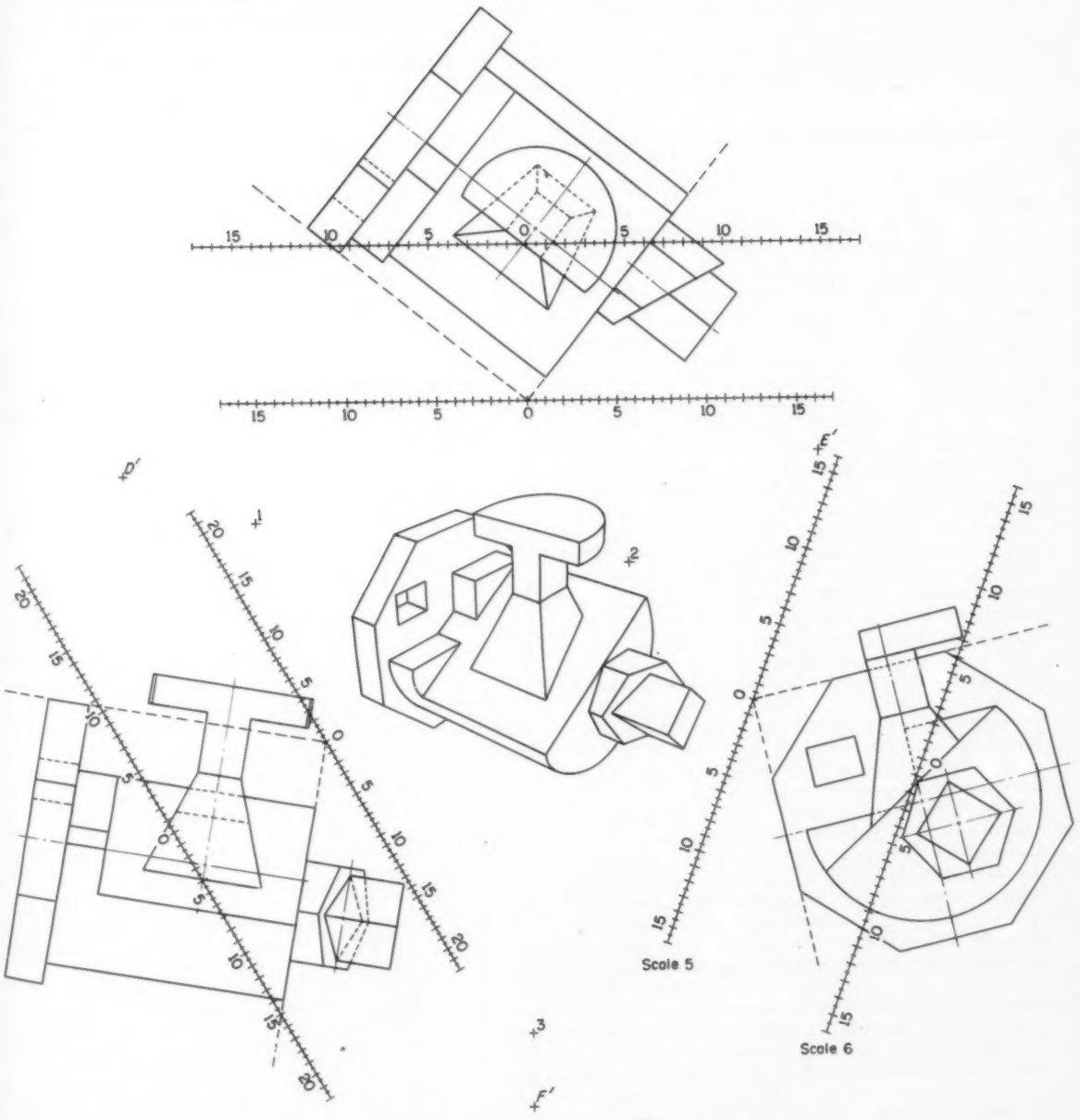


Fig. 1

XUM

Constructing the Master Sheet

1. Establish axes x, y, z, Fig. 2.1.
2. Locate the picture plane traces, AB, BC, AC, with lines perpendicular to their respective axes.
3. Revolve the reference planes, Fig. 2.2. Using trace AB as an example, bisect the trace, and using radius of $AB/2$, locate point F on y axis. Join points AF and BF.
4. Locate measuring point. Draw a line perpendicular to axis y from point O to trace BC (or AC), Fig. 2.2, then parallel to axis y to

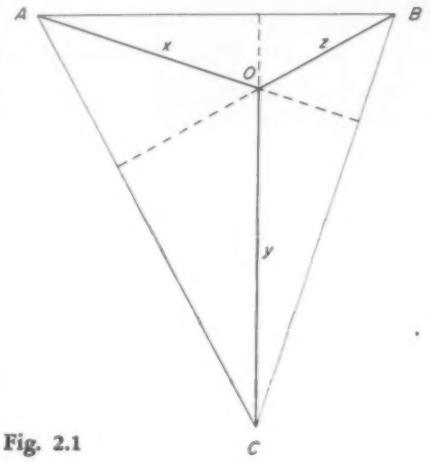


Fig. 2.1

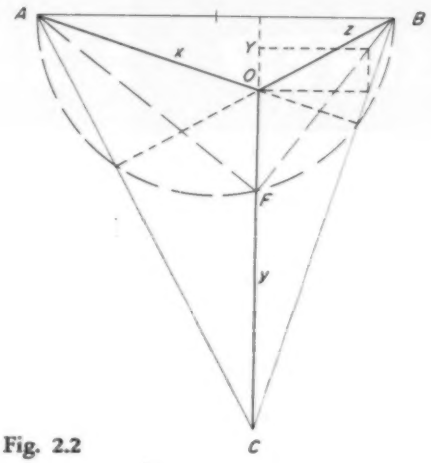
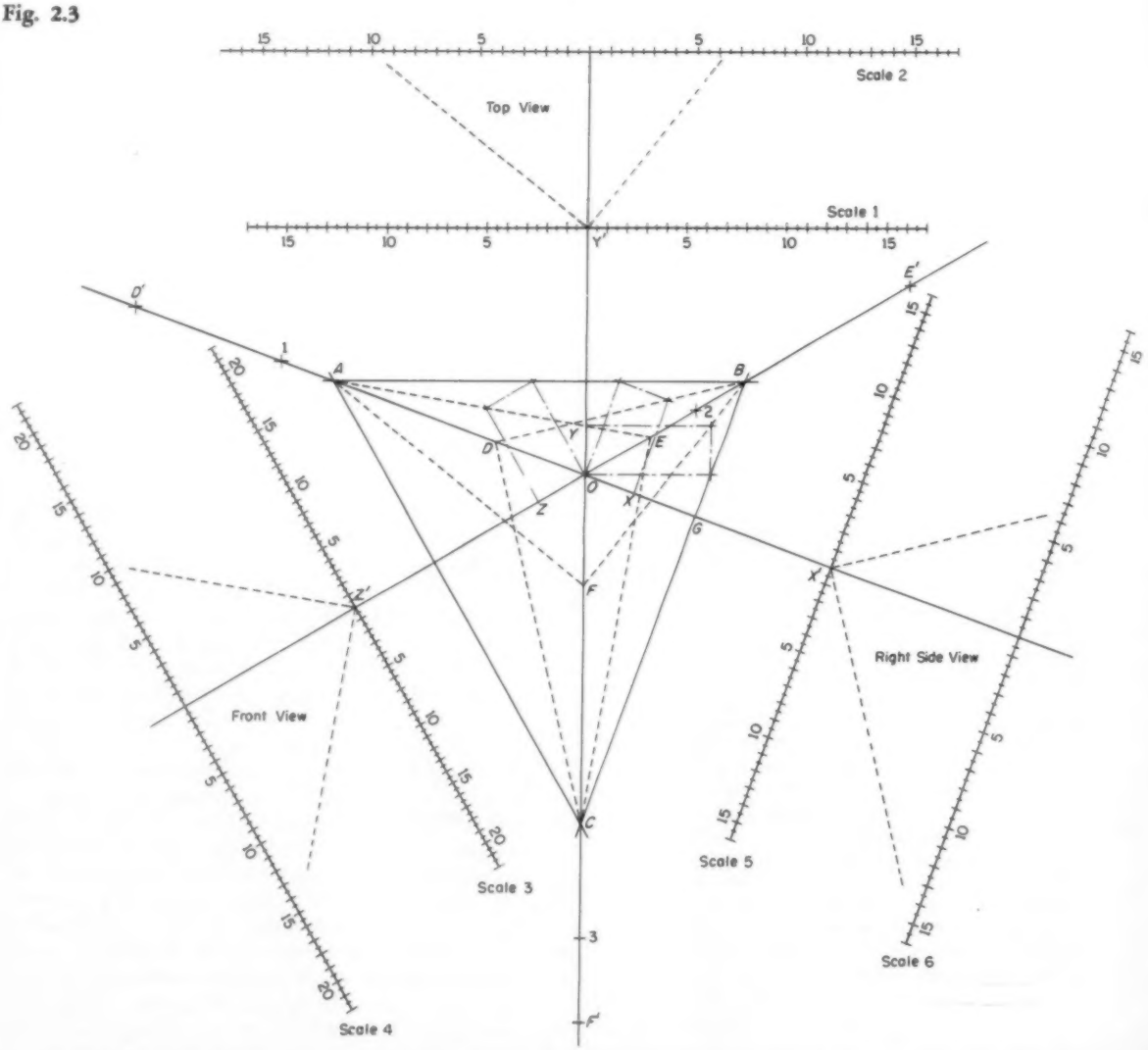


Fig. 2.2

Fig. 2.3



but does not limit the physical size of the subjects which may be drawn. Inasmuch as the master chart may be used repeatedly, two or three such charts drawn to different view angles are normally sufficient for all work which is to be done.

Use of the master chart is illustrated in Fig. 1, and its construction is given in Figs. 2.1 through 2.6. Calculations required are given in illustrations.

There is little doubt that projecting directly from orthographic views has a number of advantages over other methods. Points on circles or irregular curves become points to be handled like all others without becoming involved in some scheme of transferring co-ordinate measurements. Visualization of the pictorial as it builds up is considerably easier with the orthographic views to work from. Additional vanishing points for angular planes are unnecessary. Measuring lines are eliminated since the size of the finished drawing is based upon the size of the orthographic views.

Scales on the chart are used to align a straightedge with inaccessible points. Two steps are required, as explained in Fig. 1, one to locate the pivot point on the side of the enlarged true triangle and the other to head the straightedge for the corner of the enlarged triangle. Many ideas for placing the scales and pivot points were tried out before the present scheme was reached. Undoubtedly more improvements and refinements are possible, but the method as it stands is complete. The practical aspect of this method as a way of making perspectives is proved by Fig. 1, which would certainly be more difficult by other methods.

REFERENCES

1. S. B. Elrod—"Simplified Pictorial Drawing," MACHINE DESIGN, Vol. 25, No. 3, March, 1953, Page 128.
2. F. W. Reighard—"Perspective Drawings," MACHINE DESIGN, Vol. 27, No. 11, November, 1955, Page 148.

edge of rotated reference plane (line *BF* or *AF*), and then perpendicular to axis *y* and back to it. This locates point *Y*. *YO* is for measurement purposes and is the basis for constructing the scales on Fig. 2.3. Repeat steps 3 and 4 for other two axes to locate points *X* and *Z*.

5. Enlarge finished drawing, Fig. 2.2, by some desired factor, locating points *A'*, *B'*, *C'*, as far away as possible (usually off the board) without letting points *D'*, *E'*, *F'*, become inaccessible. Points *D'*, *E'*, *F'* represent points *D*, *E*, *F* moved to their "enlarged" positions. A factor of five was used in the chart in Fig. 2.3, i.e., distance *OF'* is 5 times distance *OF* and other dimensions are similarly enlarged. In the calculations a considerable amount of time may be saved by scaling the necessary dimensions and multiplying by the enlargement factor or by stepping off with dividers. The dimensions 36 (5 times *AX*), 16.71 (5 times *DX*), 23.91, and 43.20 are thus located on line *A'G'*, Fig. 2.4. If the original drawing is carefully made these points are sufficiently accurate.

Fig. 2.4

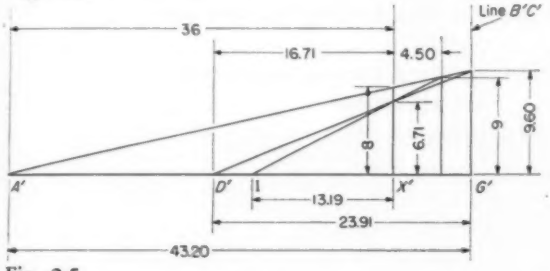


Fig. 2.5

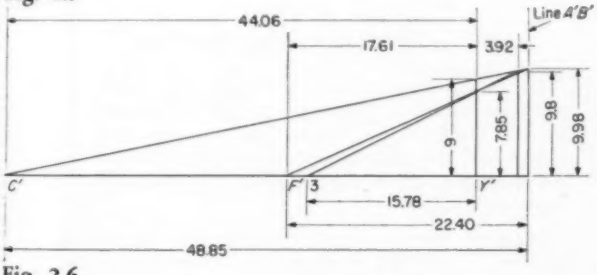
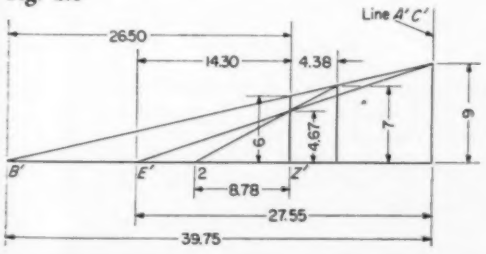


Fig. 2.6



6. Locate the scales and scale moduli. The calculations will be explained using the right side view and Fig. 2.4 as an example. The scale at *X'* is used both as a graduated scale and a pivot line. The other graduated scale is to be placed out from point *X'* and must be, due to space limitations, about 5 in. away. Consequently the proportion 36:36 + 5 is set on the slide rule to determine what convenient numbers come close to this ratio. The numbers 8 and 9 are decided on and become the scale moduli. This changes the distance between scales from 5 in. to 4.5 in., and establishes their vertical length in the triangle, Fig. 2.4.
7. Calculate the scale moduli. It is necessary to find the modulus of a scale on line *B'C'* which will align with scale *X'* and its modulus of 8, and *A'*. By similar triangles the proportion, 36/43.20 = 8/unknown, is obtained, yielding a scale modulus of 9.60. Next it is desired to find the modulus of the pivoting scale which coincides with scale *X'* in position. The proportion, 9.60/unknown = 23.91/16.71, is obtained, giving a value of 6.71 as the scale modulus.
8. Find point 1. The above information is sufficient to locate point 1 by similar triangles. The proportion (distance *X'* to point 1)/6.71 = 4.50/(9 − 6.71) gives 13.19.
9. Graduate the scales. Choose some convenient scale and scale 8 units on scale *X'* and 9 units on scale 6, Fig. 2.3. They may, of course, be subdivided as many times as desired. The eye is quite critical in estimating proportion and a minimum of marking is sufficient.

The process is repeated for the top and left views, Figs. 2.5 and 2.6. When this is finished, the master chart is ready for use.

Production Design Techniques for

Cold Roll Forming

- **Factors a designer must consider in specifying cold roll forming as a method for production of parts**
- **Advantages and limitations of the process**
- **Planning the part for easy production**
- **Auxiliary forming and production operations**
- **Tolerances**
- **New metals**

COLD roll forming is the process of continuous shaping, without heat, ductile sheet or strip metal with a series of progressive forming rolls. Because of high production capacity, uniformity of cross section or profile throughout part length, and closely-held dimensional tolerances, roll forming is extensively used.

The automotive industry, for instance, relies on roll forming for millions of feet of trim, scuff plates, and rims. Aircraft designers specify roll-formed structural members such as hats, channels, zees, tees, and others.

In many cases, accelerated production rates and the added strength gained from cold working have caused replacement of extrusions by roll-formed sections. Cold roll forming permits conversion of materials with high strength properties into desired design configurations, Fig. 1.

Action of the rolls against the metal tends to improve the natural finish, besides adding strength. For this reason, roll-formed metal shapes in the building industry have become roofing, siding, joists, window and door trim, screen frames, conduit, gutter and downspouts, lighting fixtures, and ridge rolls. Farm buildings, garages and hangars utilize corrugated roofing and V-crimp sheets.

Roll-formed lock-seam and butt-seam tubing are universally popular as electrical conduit, alpeth cable and television antennas. Trailer manufacturers have adopted special structural sections for their monocoque or stressed-skin structures and sharply corrugated floor partitions.

Planning for Cold Roll Forming

Emphasis must be placed on the high production capacity of cold roll forming when selecting

Table 1—Cold Roll Forming Machines

Many sizes of machines, having various shaft diameters and horizontal distances between shaft centers, are available. Dimensions governing roll design and the mild steel capacity of a few of the machines commonly employed for cold roll forming are:

Shaft Diam (in.)	Horizontal Distance Between Shafts (in.)	Mild Steel Capacity: Area of Section (sq in.)
1½	11	0.5
2	15	1.125
2½	18	1.750
3	24	2.500

Such machines are available commercially with up to 20 sets of shafts; however, 10 shafts are most common. Capacities given depend on shape of the section to be formed. Sections of the same height will require anywhere from 4 to 20 passes, depending on the shape.

Tubes & Shapes

By Richard T. Angel, *Senior Tool Engineer*
Pilotless Aircraft Div., Boeing Airplane Co.
Seattle, Wash.

this process as a method of fabrication. Roll forming machines, Table 1, operate at speeds ranging up to 200 fpm which, when translated to actual footage produced, amounts to 3000 to 5000 ft per working hour. Without considering amortization of the roll forming machine, the engineer may be guided generally by the following factors when weighing roll forming as a means of fabrication:

1. At least 50,000 ft annually to amortize tooling. This footage may be a total of several standard sections to be formed on the same rolls. Consideration must be given to the number of setups required to attain the total footage.
2. Consistent uniformity of section throughout part length is desired.
3. Minimum sectional tolerances and tight radii are required.
4. Section can be cut to part length as a combined operation.
5. Section may be pierced, notched, coiled, stencilled or embossed as part of the roll form operation.

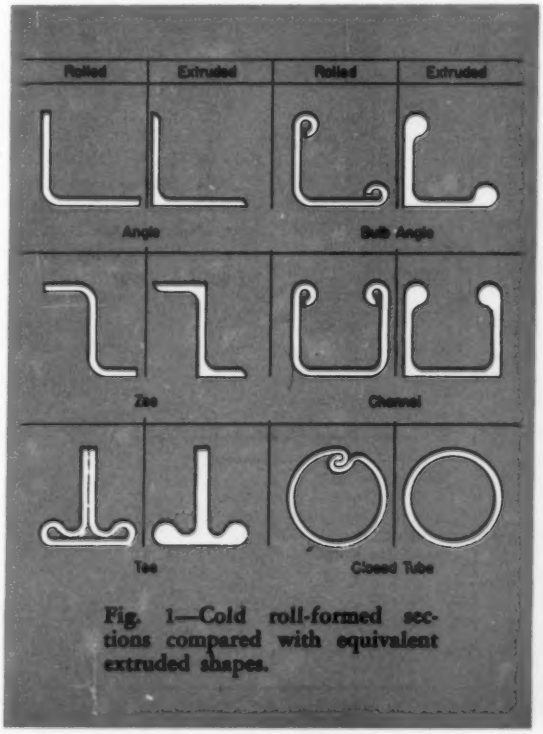


Fig. 1—Cold roll-formed sections compared with equivalent extruded shapes.

These factors all add up to less handling and a low unit cost. Where continuous production of single sections or collected standard sections involving from 25,000 to 50,000 feet per 8-hr day is desired, roll forming is by far the most suitable of fabrication processes.

Advantages and Limitations

Any ductile material can be formed from thicknesses ranging as low as 0.005-in. and up through 0.750-in. Height and width of section is limited only by the capacity of the machine, and length is limited only by length of the coiled stock. Flying cutoff units, used in conjunction with the roll forming machine, make it possible to cut sections to part lengths as short as 12 in.

The material to be formed directly affects the number of passes required, and design of tooling necessary to compensate for varying springback. Some materials "pick up" or gall, and this tendency affects the steel used for rolls and hardness of the rolls. Extreme galling sometimes requires chrome plating of the rolls to gain a specified section finish.

The hard or tempered metals often tend to crack or break at the radii. Progressive forming

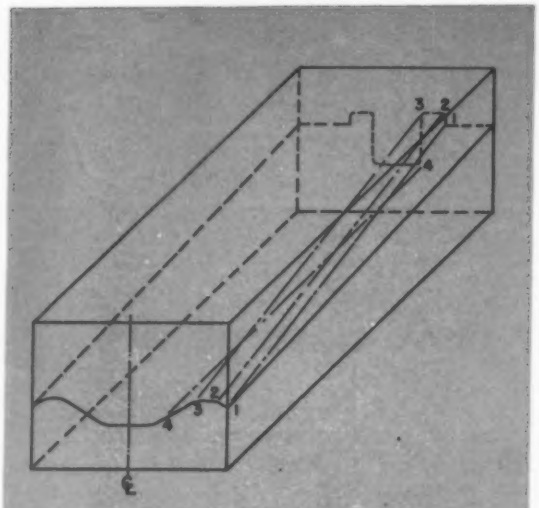


Fig. 2—Theoretical roll form layout. The shape represented by a cross section at any point could be used as a forming roll shape.

of each radius can reduce this tendency. It is practical to roll form a ductile material to a zero inside radius or a near sharp outside radius by forming the sharp corner into the strip before bending the matching side walls. The outside radius can then be coined almost square.

When considering design of a section whose probable quantities will warrant cold roll forming the designer may be guided by several general rules:

1. **Avoid extreme depth of section.** The available roll forming machine may control this factor.
2. **Avoid vertical side walls.** A slight angle is an aid to forming. This reduces metal scoring and unnecessary roll wear.
3. **Avoid blind corners or radii.** Forming accurate sectional dimensions is easier where the section can be controlled by the rolls.
4. **Design radii as large as possible.** The outside radius must ordinarily be at least metal thickness. The type of material being formed governs the possible inside bend radii. Ductile or untempered metals can be formed to zero inside radius, but tempered metals require greater radii to prevent cracking. Many handbooks give standard bend radii for materials based on brake forming or other methods of straight bending. As a "rule of thumb," these standard bend radii may be reduced one thickness for roll forming.

Production Design Considerations

Determining Number of Passes: Theoretically, a roll form layout may be compared with a solid block of die material wherein is machined the shape to be formed, "faired" from flat to finished section, Fig. 2. If this block were divided into an infinite number of "slices," each slice could be converted into a roll and become a roll form pass. Obviously the more slices, or greater the length from flat to finished shape, the easier the progressive forming operation. Naturally, excess cost prevents the use of too many passes, so the minimum number of passes required to perform the forming operation must be determined.

A longitudinal forming angle of 1° 25′ has been found applicable as a guide in determining the number of roll passes required for simple shapes. In complex sections having multiple bends, each bend must be calculated individually for the number of passes required to form that bend. Then, after combining bends wherever practical, the total number of passes can be determined.

For simple shapes, the forming length of metal required to change from a flat cross section to the one desired will be equal to the height of the desired section or segment of a section multiplied by the cotangent of 1° 25′, or

$$F = 40.436\ H$$

where F = forming length, in.; and H = section height, in. For the 2-in. high channel shown in Fig. 3, $F = 40.436\ (2) = 80.872$ in.

The forming length divided by the fixed distance between shafts or spindles on the roll-forming machine to be used and raised to the next highest whole number gives the number of passes required to perform the bending.

To form the 2-in. high channel, Fig. 3, on a machine having a 15-in. horizontal distance between shafts or housings, the number of passes

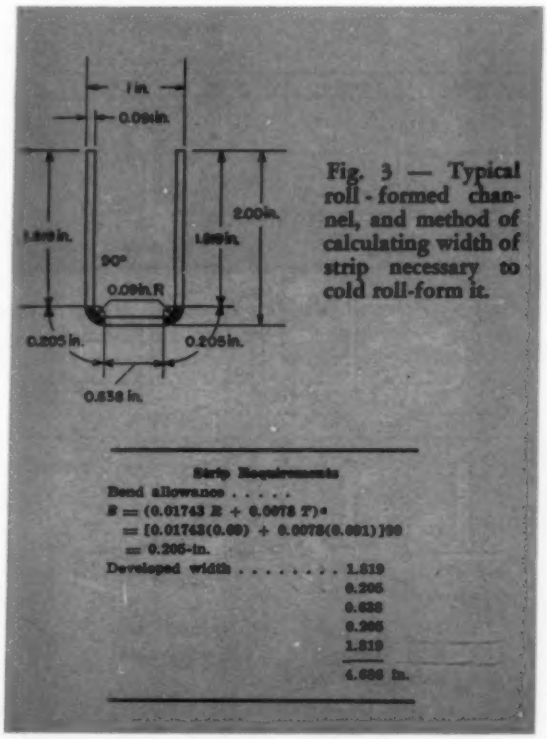


Fig. 3 — Typical roll-formed channel, and method of calculating width of strip necessary to cold roll-form it.

required would be 80.872/15, or 5.39. Raised to the next highest whole number, the work requires six passes theoretically. The calculations are for one bend. It is obvious that the section is symmetrical and both bends can be accomplished at the same time.

For multiple bends on complicated shapes, the section must be broken down and each bend or pair of bends calculated individually to determine the number of passes required to form that bend. The total number of passes can then be determined by combining passes wherever practical.

The Z-section in Fig. 4 was designed to be formed about the pitch line or neutral axis and rotated 30 degrees from the horizontal plane. Following the principle of avoiding vertical side walls and by dividing up the required forming symmetrically, the most is gained from each roll pass. By calculation, the 1-in. high flange requires three passes to form; the ¼-in. high flange requires one pass to form. The bends on each side of the vertical centerline can be combined and formed simultaneously. To help thread the strip through the machine, a shallow form should be maintained in the first pass. For this reason, a starting pass is added to this section for a total of five passes.

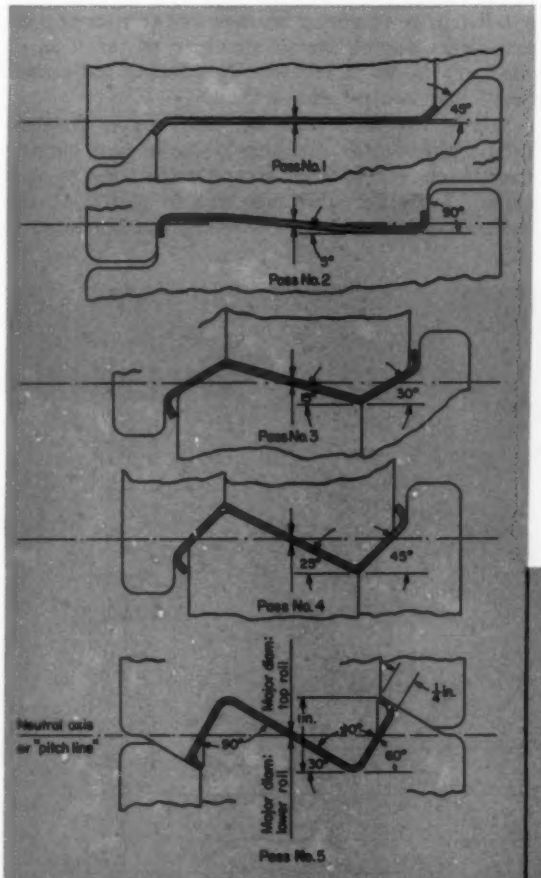


Fig. 4—A Z-section requiring multiple bends. Each bend must be calculated individually to determine the number of passes required.

Sometimes a section must be formed from a ductile metal with a zero inside radius and a near-sharp outside radius. The method is illustrated by Fig. 5.

Calculating Material Requirements: Given the dimensional cross section of the shape to be cold roll formed, it is necessary to calculate the developed width or "stretch-out" of strip material required. Straight segments on the cross section of the desired shape are added to the bend allowances, calculated from the following conventional equation to determine this width. The equation is applicable for use with all metals.

$$B = (0.01743\,R + 0.0078\,T)\,\alpha$$

where B = bend allowance, in.; R = inside radius of bend, in.; T = metal thickness, in.; and α = angle through which the metal is bent, degrees.

For example, to cold roll form a channel 2 in. high by 1 in. wide, Fig. 3, it would require a metal strip 4.686 in. wide.

Roll Manufacture: Rolls can be made from unhardened, low-carbon steel when relatively small quantities of simple shapes are to be formed. In many instances laminated plastic materials and cast iron are used as segments of rolls where extreme wear is not expected or as spacers between forming segments. Plastic laminated materials are often used to fabricate entire rolls for low production runs, although the final roll pass should always be made of steel.

For most shapes, however, and for longer tool life on large-production runs, rolls should be made from a good grade of oil-hardening tool steel, heat treated to Rockwell C 58 to 62. When the shape being formed is from hot-rolled unpickled steel, the roll material should be high-chrome, high-carbon steel to resist abrasive wear on the rolls.

Fig. 5—Method of obtaining a zero inside radius: *a*, by depressing or coining the strip in thicknesses over 0.032-in.; *b*, by roll-beading in 0.032-in. thickness or less. Since method *a* requires a depression of approximately 1/3 the material thickness, it it not recommended where structural corner strength is desired.

For additional roll wear life and for improved part finish with elimination of "pick-up," rolls are often chrome plated after hardening and grinding.

Rolls are turned on lathes, allowing 0.010-in. of stock on all surfaces for subsequent grinding.

Segmental or split-roll construction can be employed if it will not interfere with satisfactory rolling of the part. Segmental rolls are more economical to manufacture, and they often can be used with spacers to form a variety of shapes and sizes. This reduces the tooling cost for any section which can be adapted to standardization and makes replacement of worn segments economical with minimum down time.

Extra Forming and Production Operations: Theoretically, if the rolls are designed properly and built accurately, guides or other corrective devices should not be needed between passes. There are occasions, however, where the machine shafts are too far apart to permit the material to thread or "fair" itself from one pass to the next. In such cases, plastic, fiber or kirksite guides are attached between passes to stools on the roll-forming machines.

Another important service performed by intermediate guides is that of doing actual work on the metal being formed. This work may range from simple overbending, compensation for springback, to actually forming reverse bends with horizontal idler or driven rolls. Fig. 6 shows a section using a horizontal idler roll setup for forming.

Another common use of the intermediate horizontal roll arrangement is in forming lock-seam tubing. The hooks are formed slightly open, and intermediate horizontal rolls "snap in" the hooks preparatory to sealing or crimping by the subsequent pass. Fig. 7 illustrates the use of these horizontal rolls between passes 6 and 7 and is also an example of lock-seam roll forming.

Springback is encountered to a varying degree, depending upon the design of the section, the properties of the metal, and the method of forming. It may be overcome by overforming in the next-to-last pass.

Cold roll forming machines may be equipped with a bending stand at the outfeed end, on which various yokes or shoes can be fastened. These can either apply deliberate coiling to the finished section or correct any tendency toward bending or twisting as the section leaves the final pass of rolls. If deliberate coiling is desired, adjustable coiling rolls designed either as idlers or as driven rolls can be provided, Fig. 8.

Just as nonconcentric rolls or machine shafts will cause metal stretching with resulting part waviness, this principle can be utilized to encourage a coiling tendency. In this case, the next-to-last pass of a section to be coiled finishes the shape dimensionally. The last pass incorporates a relief in the forming surface of the rolls to permit direct application of pressure to the area of the part to be stretched. The coiling rolls then "set" and control the coiling.

Where the section being produced is finished in straight lengths, shipping pieces or part lengths may be cut off without stopping the forming machine. A flying cutoff machine is placed at the outfeed end of the roll forming machine and a

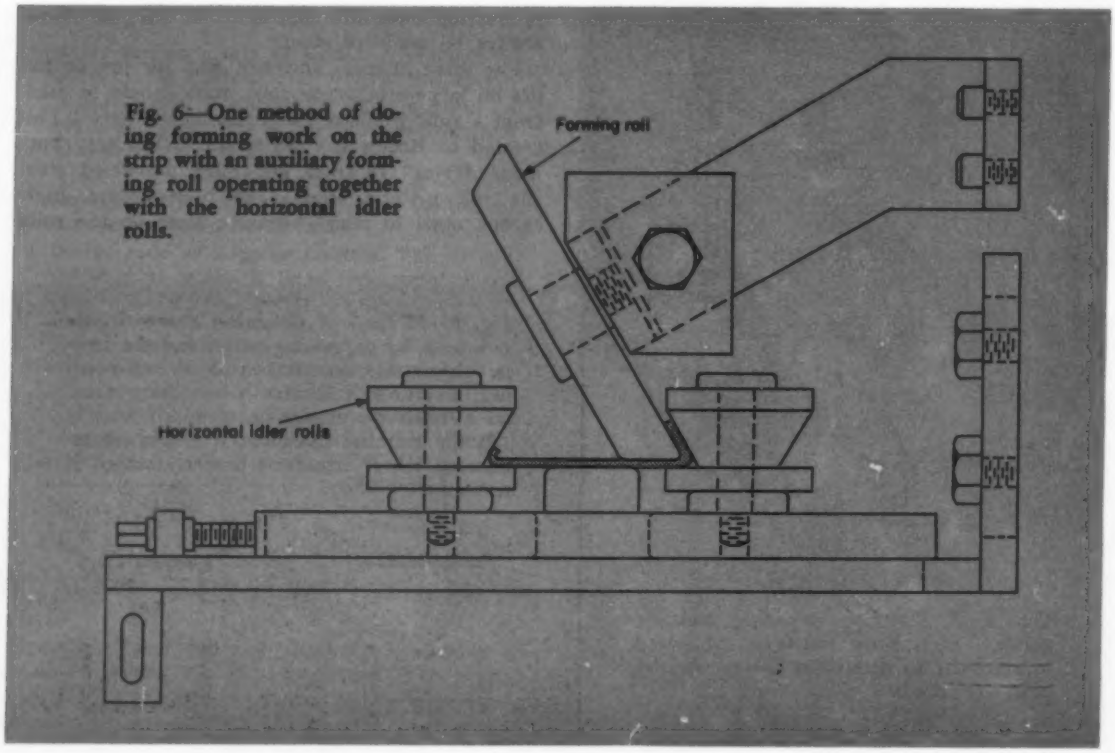


Fig. 6—One method of doing forming work on the strip with an auxiliary forming roll operating together with the horizontal idler rolls.

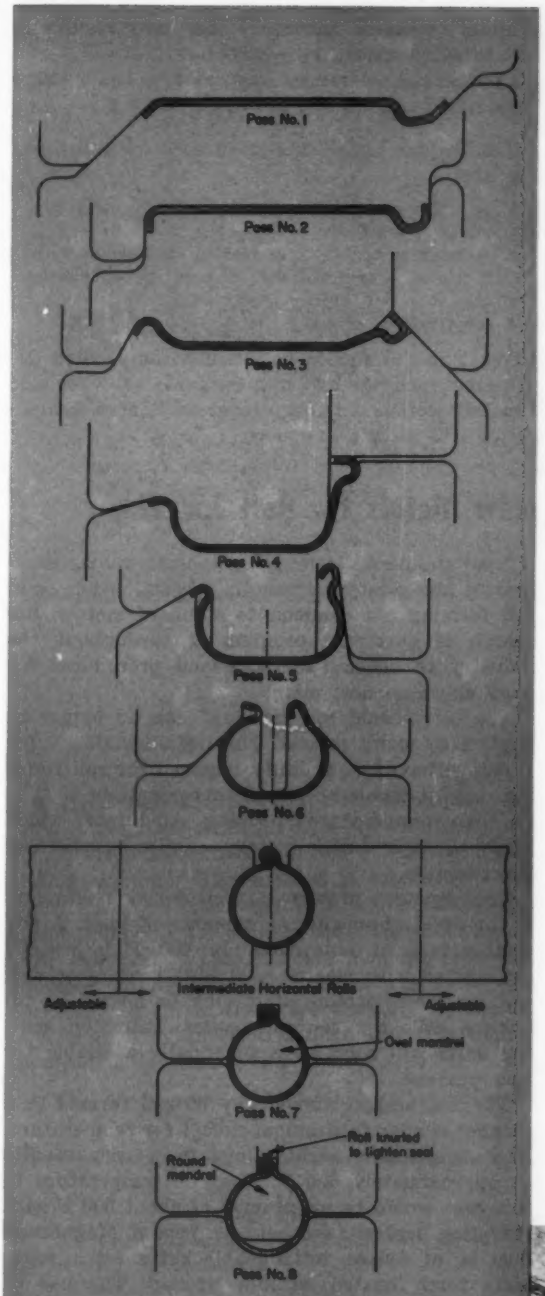


Fig. 7—Above—Layout of passes to roll-form a lock-seam tube. Horizontal rolls between Passes 6 and 7 snap in the section preparatory to locking the seam. Knurling the seam at the last pass tightens the lock.

Fig. 8—Right—A hooked Z-section coiled to finished-part radius by adjustable idler coiling rolls. The hook on the stretched flange is formed in these idlers to help "set" the radius.

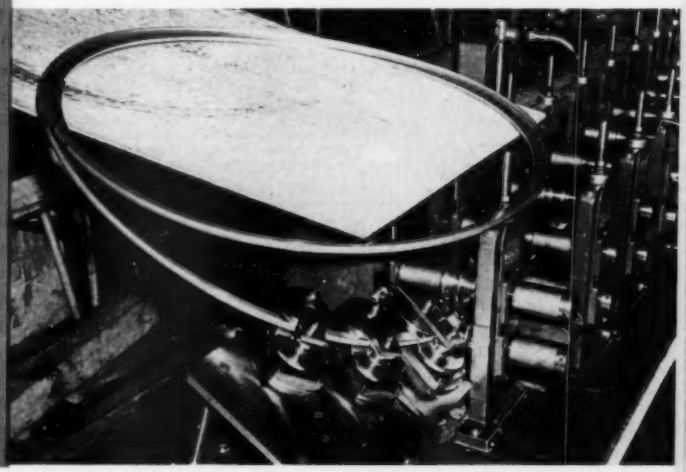
mechanical device is mounted on the runoff table to actuate the flying cutoff trip mechanism. When closed sections, such as lock-seam tubing, are to be cut off, it is most practical to attach a high-speed saw to the head of the cutoff machine. Use of a saw prevents collapse of the section.

Cold roll formed sections, to serve their final purposes must generally have other production operations performed on them. Many of these operations, such as piercing, slotting, trimming, embossing, numbering and printing, can be incorporated into the roll-form tooling. In general, these operations are performed with rolls located ahead of the first forming pass. Piercing or slotting punches are mounted on a flat "male" roll, and the dies in a flat "female" roll. The roller dies are designed to punch the slugs completely through the metal strip. The designer must position such holes in even divisions of the circumferences of the roll pitch diameters. They may be arranged in almost any order within the capacity of the roll diameters.

When it is desirable to identify the section being rolled by marking with ink, the operation may be performed at either the infeed or outfeed end of the machine. If inking rolls are used at the infeed end, the ink must be of the quick-drying type to prevent smearing by the roll-form lubricant. An air hose attached to the machine helps dry the ink before the first forming pass.

Many production setups can combine other operations and other machines with the standard cold roll forming machine. Perhaps the most common of these occurs in the rolling of seam-welded tubing. The tubing is roll formed as a butt seam, cleaned, welded, burred and coiled or cut to length. The welder, with cleaning, sizing, straightening, and burring attachments, is mounted at the outfeed end of the roll forming machine.

Another unusual adaptation is the cold roll forming of shapes with special closed cross sections. First, a round lock-seam tube is rolled. Then a special rolling head converts the circumference



to the periphery of the cross section desired, Fig. 9.

This method is particularly advantageous if several closed shapes of different configurations are designed to have the same developed width or "stretch-out." The initial tooling expense is considerably reduced by having only one set of main rolls to form a tube and separate special head rolls to convert the tube into the desired shape.

The process is limited to comparatively shallow bends and sections without sharp radii or deep grooves. The special rolling head is set up similar to a regular roll pass and is simply a housing containing rolls adjustable for forming both in horizontal and vertical directions and combinations of each. This head is also designed for use as a tube straightener.

Tolerances for Roll Forming: Width of the metal strip to be roll formed is determined from the calculated stretchout of the section, as described previously. Tolerances on strip width when shoulder stops are incorporated in the roll design should be ±0.005-in. It is often necessary to install cutting rolls at the infeed end of the roll form machine to size the strip before forming. When shoulder stops are not used and part specifications are not critical, the strip width tolerance may be increased to ±0.015-in.

The most important requirement regarding the metal strip to be formed is freedom from camber. Camber in the strip constitutes a "built in" warp in the rolled section; it is extremely difficult to remove. Ordinarily mill tolerances on strip (2 in. in 20 ft) can be tolerated and corrected after rolling with the outfeed straightener. If the part specifications are severe, it is often desirable to remove the camber by stretching the strip before rolling. An elongation of approximately 2 per cent is required for this purpose.

Metal thickness tolerances, for best results in roll forming, should be ±0.0015-in.

Commercial tolerances applicable to the average roll-formed section are shown in Table 2.

Table 2—Commercial Tolerances for Roll-Formed Sections

Piece length	±1/32-in. using automatic cutoff. Standard lengths: 12 in. to 20 ft.
Twist	Not to exceed ½-deg per ft to a max of 5 deg except where twist can be corrected with light hand pressure.
Cross-section dimensions	±1/64-in. on fractional dimensions (to 0.031-in.); 0.015-in. on closed decimal dimensions.
Angles	±1 deg up to 0.064-in.; ±2 deg up to 0.125-in.
Straightness	½-in. in 12-ft lengths except where bow can be corrected with light hand pressure. In no case more than ½-in. in 12 ft.

Fig. 9—Shapes converted from round lock-seam tubing with a special rolling head.

Lubricants: Lubricants often used for roll forming are:

1. A solution of one part soluble oil with five parts of water.
2. A mixture of 1½ lb of melted lead oleate with 1 gal of warm solvent in turn mixed slowly into 50 gal of thinner or solvent.
3. Any solvent alone.

Items 2 and 3 should be specified only when degreasing facilities are not available or when the finished section is to be primed or painted. Evaporation will leave a dry piece.

New Metals for Roll Forming

New stainless steels, the titanium alloys, magnesium and other new metals present problems in roll forming not common to standard metals. Research is currently progressing throughout the industry to develop methods and procedures for working these new metals.

The term "cold roll forming" can no longer be applied to many metals. The titanium alloys, for example, have the ductility required for roll forming only at temperatures of approximately 1000 F. At this temperature, forming conditions which apply to other ductile metals are also satisfactory for titanium.

The greatest problem in roll forming titanium is the application and maintenance of heat. A roll temperature of approximately 400 F is usually maintained with electric cartridge heaters or disk heaters. The titanium strip may be heated by induction coils between roll passes. Induction heating units will soon be commercially available for this purpose.

The magnesium alloys may be roll formed in a manner similar to titanium except for temperature. Most magnesium sheet alloys form very readily at approximately 650 F. The roll temperature in this case would be maintained at about 500 F with induction heaters used between passes. Magnesium dust is, of course, inflammable but sheet is regularly torch heated without mishap. The use of infra-red lamp heaters has also been successfully applied to forming magnesium sheet.

Thoriated magnesium is a new alloy gaining popularity because of strength, light weight and high-temperature properties. Forming properties of this material are the same as for other magnesium alloys except that thoriated magnesium is mildly radioactive. Although this is not harmful in a well-ventilated area, standard procedures governing the handling of such materials must be applied.

Metals which require heat for roll forming have several apparent disadvantages. These are largely offset by the reduction of springback, which is negligible at the elevated temperatures, and the possibility of forming much smaller bend radii.

How to use
Adding Machines as Calculators

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ARITHMETIC problems of addition, subtraction, multiplication or division can often be carried out on a "ten-key" type adding machine. This method is especially useful when an electric calculator is not available and a slide rule will not provide sufficient accurary.

In essence, all calculators are simply specially equipped adding machines. Therefore, it is only necessary to fill in the steps that are automatically handled by an electric calculator. Six factors involved in developing this process are:

1. The fundamental basis for all mathematics is

Addition

. . . when the number of columns exceeds the capacity of the machine.

PROBLEM: Add

23456789567
34567895432
56789567854
56437867543

SOLUTION: The numbers can be broken into two parts and each part added:

23456	789567
34567	895432
56789	567854
56437	867543
3	120396
171249	
171252	120396

Multiplication

. . . when the problem exceeds the ordinary capacity of the machine.

PROBLEM: Multiply 23456 by 34567.

SOLUTION: Any two numbers can be directly multiplied together by an adding machine if the total number of digits does not exceed the number of columns the machine was built to handle. This example has a total of ten digits. It could be handled directly by a ten-column adding machine. If, however, only a seven-column machine is available, the problem must be broken down:

23456	23456	23456
3	45	67
70368	1055520	1571552

Then the figures are arranged in proper columns and added:

157	1552
10555	20
70368	
	3552
81080	
81080	3552

Since each factor has only five significant digits, the product usually would be rounded off to 81080. The decimal point depends on the problem, as in the operation of a slide rule.

If preferred for speed, the numbers can be rounded off at the first stage, thus:

$23456 \times 67 = 1571552$ or 15716

This can be added to the product of 23456 $\times$ 45 by adding 15716 before taking a total:

$(23456 \times 45) + 15716 = 1071236$

which can be rounded off two places to give 10712. This, in turn, is added to the product of 23456 $\times 3$ to obtain 81080. Again, the decimal point is found by estimation as in the case of a slide-rule manipulation.

matching. (Shepherds may have used this method in accounting for their sheep. By matching one stone in an old pelt bag for each sheep, it was possible to tell when they were all in the same fold.)

2. Counting was derived from matching.
3. Addition was derived from counting.
4. Multiplication is simply the addition of one number another number of times.
5. Subtraction is the reverse of addition.
5. Division is a special case of subtraction. Dividing 100 by 5 is, in effect, finding the number of times 5 can be subtracted from 100.

These six factors are the bases for extending use of the adding machine. Many shortcuts can be derived from them.

The manual that comes with the adding machine shows how to add, subtract and multiply. Using this and the six factors, it is possible to extend use of the common adding machine to such problems as division, multiplying numbers that seem too large for the machine, or adding numbers that have more columns of digits than the machine is built to handle.

The adding machine can not only substitute for an electric calculator, it can also be helpful in checking slide-rule work. One may make the same mistake over and over again, but by using a different tool he may find the error without wasting more time.

A few minutes spent learning how to get the most out of an adding machine may mean hours saved when time is at a premium. The accompanying examples illustrate the possibilities.

Division

The electric calculator has a device which automatically determines how many times one number can be subtracted from another. The number of times is the quotient and is registered on the appropriate cyclometer. In using an adding machine for the same purpose, a slide rule is used to find the trial divisor, thus indicating how many times to pull the handle. The remainder is the immediate goal. After the remainder is found, the process is repeated.

PROBLEM: Divide 23456 by 3456.

SOLUTION: By slide rule the trial divisor is found to be 67 for the first two places. Thus, on a seven-column machine, 345600 is subtracted 6 times and 34560 is subtracted 7 times, as follows:

2345600
−345600
−345600
−345600
−345600
−345600
−345600
−34560
−34560
−34560
−34560
−34560
−34560
−34560

leaving 30080. If only four significant digits are required, 30080 may be divided by 3456 on a slide rule and read only two figures for the next two digits. It is found to be closest to 87. The entire quotient is then 6787, and the decimal point is found by inspection.

Tips and Techniques

Computing Segment Areas

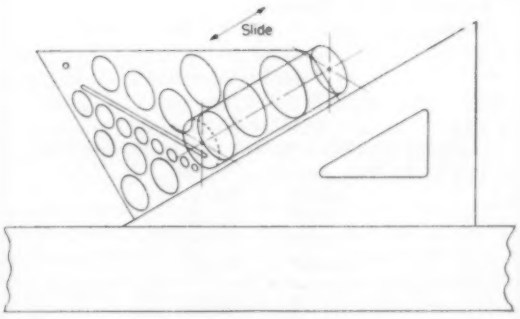
Conventional methods for determining the area of a segment of a circle are rather lengthy when compared with an approximate formula,

$$A = \frac{2ch}{3} + \frac{h^3}{2c}$$

which is correct to within 1 per cent or less.—ARNE BENSON, *Sanders Associates Inc., Nashua, N. H.*

Drawing Ellipses

An isometric ellipse template such as the Rapidesign No. 123 may be more useful if it is cut in half to provide edges parallel to the minor axes of the ellipses. Halves of the template may then be moved along a 30-60 degree triangle so that ends of a shaft or any cylindrical shape can be drawn in a minimum of time and in perfect alignment.—THOMAS D. REID, *Aeronautical Communications Equipment Inc., Miami, Fla.*



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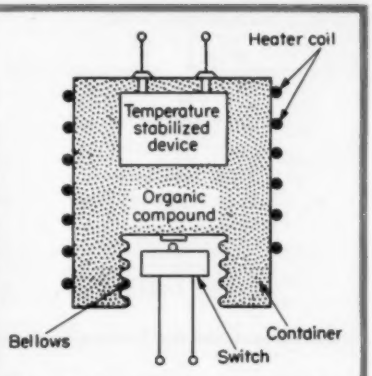


Fig. 1—Typical components of a fusion-temperature controls.

Looking for a way of developing high-level, precisely modulated forces for a control-system application? The remarkable volume expansion that results when certain organic compounds are melted provides such an action. Exact nature of the isothermal fusion process is reviewed in this article, and practical suggestions are given for the design of fusion-operated bellows actuators, temperature controllers and constant-temperature baths.

Fusion-Temperature Controls

By W. S. Crocker and H. H. P. Lemmerman
General Electric Co., Electronics Div., Schenectady, N. Y.

OBSERVATION of the *fusion* process—which is what happens when a solid melts to the liquid phase—reveals two salient facts: (1) the melting substance experiences a considerable change in volume, and (2) temperature of the solid-liquid mixture remains fixed at the melting point until the fusion process is completed. Such change-of-phase effects have found useful application in the design of precision temperature controls.[1] Development efforts along these lines, however, have been quite limited, especially when contrasted with the work done on controls making use of the much smaller volume coefficient of expansion of liquids and gases. Literature on the subject, moreover, has not stated specifically the types of compounds that can be used, nor has it placed much emphasis on the isothermal nature of the fusion process.[2]

Changes in volume that occur during fusion are quite large—amounting on the average to about 10 per cent of initial volume. Furthermore, the energy available from this process is very high. To achieve equivalent mechanical action with a bimetal-operated controller, 5000 times as much material would be required as in the fusion temperature device. Such volume changes can be used to actuate mechanical components such as bellows and switches, valves, or dampers. By adjusting the position of the moving element—the bellows, for example—sensitivity of such elements can be controlled over short ranges. The nature of the compound fixes its exact melting point.

The design function of the fusion-temperature control unit will, of course, determine its exact configuration. But, in general, components of the device, illustrated in Fig. 1, are: (*a*) a sealed container enclosing both the compound and the device to be temperature stabilized; (*b*) a bellows mounted so as to move with volume changes in the control compound; and (*c*) a heater which holds the compound at its melting point, the heater being turned on and off by a switch actuated by the bellows.

In the design of such a unit, certain specifications are usually set on the nature of the control compound, its volume, the fraction of the compound that is in liquid form during set-point operation, bellows travel, input to the heater, etc.

In following sections of this article, these design

[1]References are tabulated at end of article.

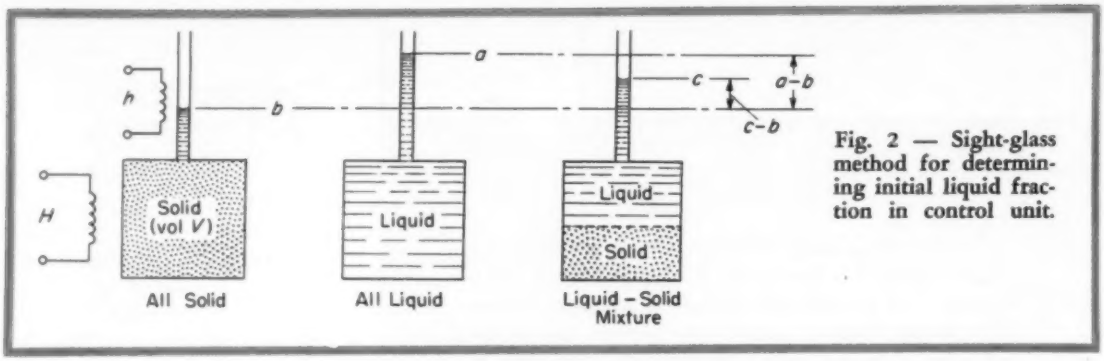


Fig. 2 — Sight-glass method for determining initial liquid fraction in control unit.

Nomenclature

A, B, K = Constants
A_e = Effective bellows area, sq in.
a, b, c = Liquid level in sight glass, in.
C = Heat of fusion, joules per cu in. ($= 68.6\ c\ \rho$)
c = Heat of fusion, cal per gm
K_r = Rate of heat transfer, watts per deg C
M = Slope, deg C per cent
T = Temperature, C
V = Volume, cu in.
W = Power, watts
X = Mixture ratio, per cent
x, y = Bellows stroke, in.
α = Fraction of container volume in liquid phase
β = Coefficient of volume expansion, per deg C
δ = Fractional change in volume during fusion
ρ = Specific gravity

Subscripts
l = Liquidus
s = Solidus
o = Intercept

points are considered, and practical suggestions on the construction of such a unit are outlined in detail.

How to Select the Control Compound: Choice of the compound that will be used for each application depends in the main on its melting point. A sharp melting point is required, but not all organic compounds can be purchased at reasonable cost with a high degree of purity. Usually the melting point specification is guaranteed only to 1 degree (C). Where the desired melting characteristics cannot be obtained with a pure organic compound, a two-constituent mixture may be used (see Appendix).

The change in volume experienced by organic compounds is quite large, averaging about 10 per cent. For some compounds, for example anthraquinoe, volume expansion may be as high as 17 per cent. After a compound that appears suitable for use in the fusion temperature control has been selected, its volume expansion characteristic may be checked last, since this quality is normally high enough for all practical applications.

When checking a compound for suitability from the long list of those available, certain additional characteristics should also be considered:

(1) Corrosiveness.
(2) Flash point.
(3) Toxicity.
(4) Solvent action.
(5) Absorption of air.
(6) Electrical conductivity.

Although some organic compounds may be bland enough at room temperatures, during the filling process they must be heated, and their fumes and solvent power may then become a hazard to personnel. Typical are the aromatic compounds which should not be melted unless adequate ventilation is maintained. Information on the toxicity of the materials that might be comtemplated for use in fusion-temperature controls is of great value.[3]

Liquid-Solid Mixture: A parameter of great

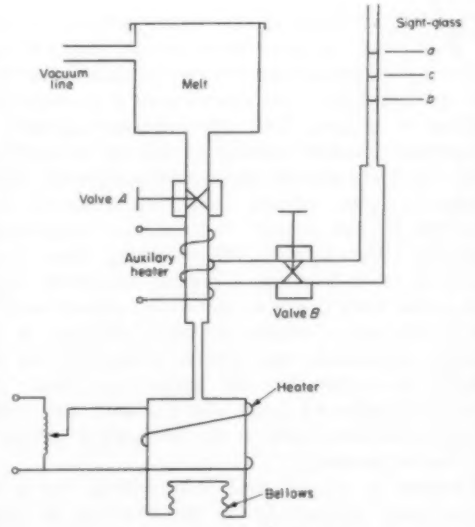


Fig. 3—Apparatus for filling fusion temperature control container.

utility in the investigation of fusion-temperature controls—due principally to its use in design formulas—is the quantity α, which is defined as the fraction of the control compound that is in the liquid phase at any instant. Consideration of Fig. 2 will provide an insight into the meaning of this term. The sketches also schematically illustrate a method that can be used to fill the fusion-temperature control with the initial liquid-solid mixture.

The three sketches (Fig. 2) show the compound occupying the controller volume in the completely solid state, the completely liquid state, and the liquid-solid state, respectively. State of the compound (liquid or solid) is determined by the current that is allowed to flow through the heater H. The compound in the sight glass is held in liquid form in all three cases by the axiliary heater coil h.

It is obvious that if the level in the sight glass moves from b to a when the solid compound is completely melted (full heater current), then the value $(a-b)$ is proportional to the total volume expansion that occurs.

Assume next that the current to heater H is adjusted to hold the liquid in the sight glass at some level c, intermediate between a and b. It follows that, if $(a-b)$ is the total volume expansion for complete melting of the compound, then expansion $(c-b)$ indicates that fraction $(c-b)/(a-b)$ of the original compound volume V_0 has now melted. Therefore, for this particular liquid-solid mixture, the fraction of the compound in the liquid phase is

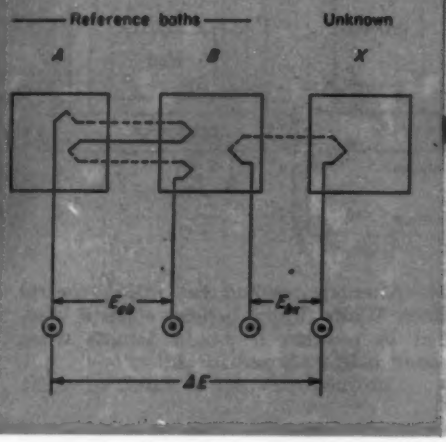
$$\alpha = \frac{(c-b)}{(a-b)} \qquad (1)$$

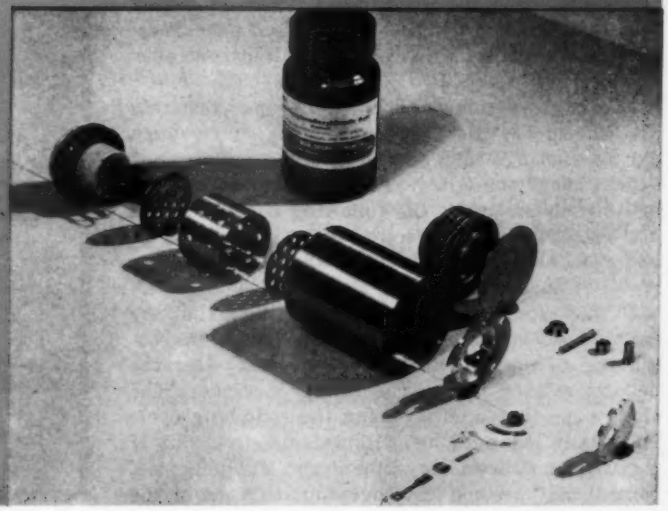
when the current i flows through the heater.

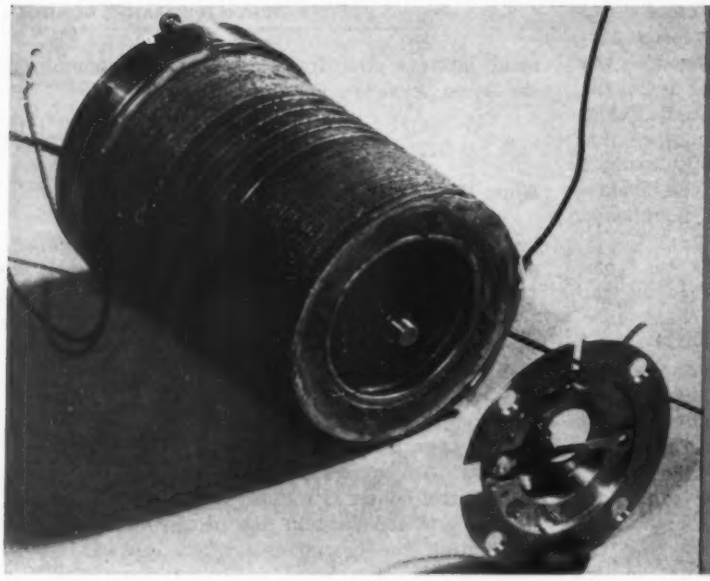
Filling Apparatus: The preceding discussion of the term α illustrates the operating principle of the filling apparatus, Fig. 3. In addition to giving a convenient means for setting α at the operating point, the filling apparatus performs several other essential functions: (1) It melts the compound; (2) It deaerates the compound; and (3) It drives the compound into the control container.

The apparatus in Fig. 3 was used to fill controllers with naphthalene. In this arrangement, the control heater is connected to a variable transformer and the vacuum line provides a means for deaerating the compound. When the vacuum is released, the compound is driven down into the control container. After the temperature control unit is filled, valve A is closed and valve B opened. With both heater circuits still in operation, the liquid level a is marked on the sight glass. The control heater is then shut off, and the melt is allowed to completely solidify. New level b is then marked on the sight glass. Finally, the current to the control heater is adjusted to stabilize the sight-glass liquid level at c. Equation

Fusion-temperature control apparatus offers a compact cold-junction reference bath for multiple thermocouple installations. In the sketch, a cold-junction reference and temperature monitor system is illustrated. Compounds in containers *A* and *B* and junction metals are chosen so that voltage E_{ab} generated between the two references will balance voltage E_{ax} generated between junction *x* and one of the references. The two voltages oppose each other and produce the error signal *E*. Photo shows a thermocouple reference designed to hold ± 0.005 C with as many as nine junctions buried in the container.







Fusion temperature control devices — because they are rugged, self-contained and use no tubes or sensitive relays—are well suited to military application. A temperature stabilized gyroscope installation is shown here. To facilitate removal of the gyro from the temperature controller, the controlling compound is sealed in a double-cup arrangement. Despite the open-ended design, temperatures hold to ± ½-C down to ambients of −60 C.

1 then gives the quantity α. The control container is then sealed off while the bellows element is in the relaxed position. An alternate arrangement for the filling apparatus is shown in Fig. 4.

Selecting the Controller Volume: Mechanical energy derivable from the melting process is, in most instances, limited by the strength of the enclosure. It should also be recalled that the melting point of the compound when subjected to very high pressures may be raised to the point where the desired tolerance on melting temperature is exceeded. To minimize the possibility of such an effect, the designer may choose a rugged, long-travel bellows and a long-travel switch. In most applications, proper overtravel should be built into the bellows and switch arrangement to ensure that all the compound can be melted without rupturing the control. Consideration of bellows area and switch travel desired leads to a simple expression for the change in volume ΔV that the compound must undergo during the switching cycle. As is shown subsequently, such an expression can be solved to give the required controller volume.

For a given compound the following constants are known: δ, the fractional change in volume during melting; and β, the volume coefficient of expansion of the liquid. For the assumed bellows and switch assembly, the following characteristics are known: A_e, the effective bellows area; x, the operating travel of the switch; and x_{max}, the overtravel in the system.

It was explained in a preceding section that the fraction of liquid α in the controller at the beginning of each switching cycle is set with the bellows relaxed during the filling operation. The change $\Delta\alpha$ that occurs during the switching cycle is usually bounded as follows: $0.5<\alpha<0.8$. If $\alpha<0.5$, the bellows may freeze up; and if $\alpha>0.8$, control may become less sharp due to some of the liquid having a gradient across some part of the volume. Generally, $\alpha = 0.7$ is considered to be about right.

Total change in the volume of the compound due to a change $\Delta\alpha$ in the fraction of liquid present can be set equal to the total volume displacement of the bellows, or

$$\Delta V = (\delta)(\Delta\alpha)(V) = A_e x \qquad (2)$$

Basis for this equation becomes intuitively clear if it is recalled that any increase in the quantity of liquid in the container is accompanied by a

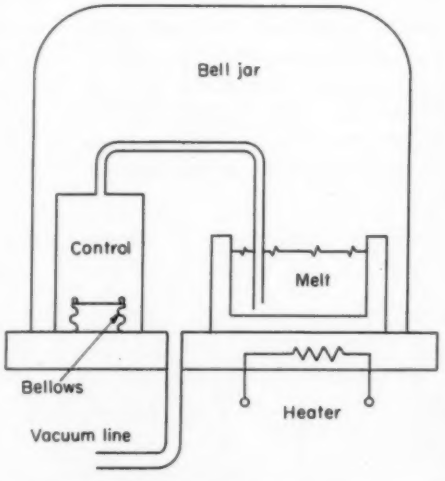


Fig. 4—Alternate method for filling control container. While filling, bellows element is restrained in position it would assume when compound is in all-liquid form.

proportional reduction in the quantity of solid. Total volume change is therefore equal to the increase liquid volume $(\Delta\alpha)V$ multiplied by the term δ.

If the possibility exists that heat will be added even after the entire compound is melted, bellows overtravel must be provided to allow for the volume coefficient of expansion of the completely liquefied compound. In this case, total anticipated volume expansion is equated to $A_e x_{max}$.

With the aid of Equation 2, therefore, the designer may select a controller volume V which gives the required travel of the bellows.

Predicting the Switch Cycling Rate: The formulas derived in this section merely serve to clarify certain aspects of the design problem. They are qualitative in nature, since the effective rate of heat transfer K_T of the control is difficult to compute in advance. In practice, a model of the device is built and the value of K_T is determined by experiment.

The temperatures that are usually specified are:

T_2 = the highest ambient to be encountered;
T_3 = the lowest ambient to be encountered; and
T_1 = the overtemperature specified $(T_1 > T_o)$.

A compound will be chosen with a fusion temperature T_o that is as high as possible. The net heat that is supplied to the system is $(W + W_o)$, where W = power supplied by heater, and W_o = power lost by device continuously.

When the lowest ambient temperature T_3 occurs, the heater should be on continuously. Therefore

$$W + W_o = K_T (T_o - T_3) \tag{3}$$

Likewise, when T_2 occurs, the heater should never turn on, and

$$W_o = K_T (T_o - T_2) \tag{4}$$

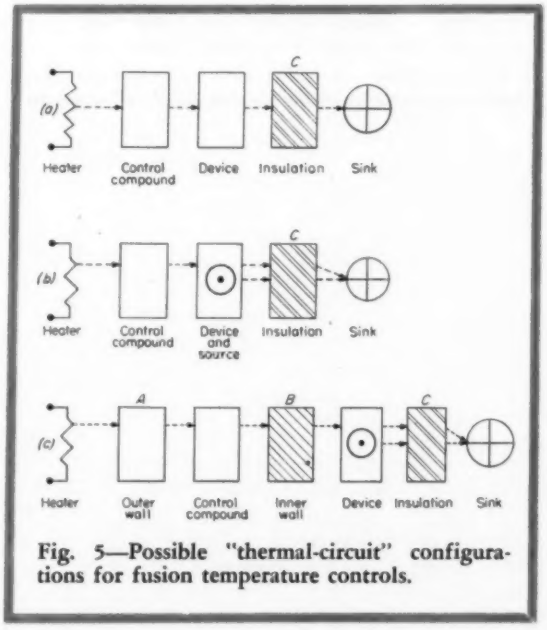


Fig. 5—Possible "thermal-circuit" configurations for fusion temperature controls.

At any ambient temperature T between these limits, the switch will cycle for a period on τ_{on} and a period off τ_{off}. The total period is therefore

$$\tau = \tau_{on} + \tau_{off} \tag{5}$$

During each of these on-off cycles the compound either receives or yields heat according to its latent heat of fusion C and the volume ΔV that changes state. The energy equations for these processes for some ambient T are

$$\tau_{on} [(W_o + W) - K_T (T_o - T)] = c(\Delta V)$$
$$\tau_{off} [W_o - K_T (T_o - T)] = c(\Delta V) \tag{6}$$

Combining Equations 3 through 6 into a single expression and taking the derivative of τ with respect to T, the minimum period (maximum switching rate) becomes

$$\tau_{min} = \frac{4\,C(\Delta V)}{W} \tag{7}$$

This factor may be used in conjunction with the life of the switch to determine how much liquid the control should contain in the event switch life is an overriding consideration.

Practical Design Considerations: If a control could be built which completely surrounds the device that is to be temperature stabilized, the design task would be greatly simplified. In practice this is not possible because there are always electrical connections that pierce the wall of the container. The existence of leads and headers is cause enough for temperature gradients to appear, and these gradients are dependent on the ambient temperature. The sketches in Fig. 5 symbolically represent three arrangements for the fusion temperature control and show the heat paths from the heater to the ambient sink.

The simplest situation is depicted schematically in Fig. 5*a*. Here the temperature gradient problem can be minimized by improving the insulation value in wall *C*. In Fig. 5*b* the stabilized device also has an input which must be dissipated, and there is a limit to the amount of insulation that can be tolerated. It may be argued that a higher melting point compound could be employed; there is, however, an upper temperature limit for the materials employed in the construction of the device itself. In Fig. 5*c* a more difficult problem is posed. Assuming that the device to be stabilized cannot be submerged in the liquid, there will be two walls through which heat must flow. In this installation, as in the other arrangements, satisfactory operation of the fusion temperature control requires careful attention to the following thermal-circuit design points:

(*a*) *Inner Wall Thickness:* The metal wall between the temperature control compound and the device should be as thin as possible. It should be pure copper. Fins should extend through the organic control compound, since large

gradients will appear in these liquids unless this precaution is taken. Naturally, the surface area of the copper in contact with the liquid should also be as large as possible.

(*b*) *Insulation Around Ports:* Rather than allow heat losses to be dissipated through the headers and leads, it is best to insulate these positions as much as possible. If heat losses are dissipated through a control compound which is a mixture of liquid and solid states, no temperature gradients can exist across the device. In practice there is room for only meager insulation over the electrical connectors, and some gradient can be expected to occur. Where space is limited, low conductivity metals will aid the designer in reducing the conductivity from inside to outside. Table 1 is a list of some of the available alloys that have very low heat conductivities.

Table 1—Low Conductivity Alloys

Type	Thermal Conductivity (per cent copper)
Stainless	
AISI Type 302	1.6
AISI Type 420	2.5
AISI Type 410	2.7
AISI Type 430	2.6
AISI Type 446	2.1
Bronze	
ASTM B144 Alloy 3A	12
ASTM B96 Type A	10
ASTM B206 Alloy B	7.5

(*c*) *Placement of Heater:* The most sensitive control is obtained when the heater is in the same container with the control compound. Installation of the heater on the outside of the container is acceptable so long as there are no short conducting paths leading from the heater to the device. In other words, all heat absorbed or dissipated from the control should pass through the control compound. The pitch or density of the heater should be increased near openings into the cavity. Heat must be conducted readily to the actuating bellows and it is best to allow areas around the bellows to warm up first.

Appendix

Two-Constituent Mixtures: Although it is desirable to use the purest compounds obtainable in a fusion-temperature control, there are often valid reasons that permit violation of this rule. For example, some controller applications may tolerate a broad melting band. In other instances it may be impossible to find a chemical with just the right characteristics and melting point. In such events, the eutectics offer the designer a wider choice of substances and a wider range of melting points than do the unadulterated compounds.

Data on phase diagrams are found throughout the literature.[4] The most expeditious approach will be to pick a compound which melts at a temperature closest to the desired melting point. Next, a phase diagram can be plotted from cooling experiments. Choice of solutes can be made from the isomers or other compounds with similar molecular structures.

Two typical examples are shown in Figs. 6 and 7. The phase diagram, Fig. 6, is typical of a compound which is soluble in its solid phases.[4] It should be noted that the liquid plus solid phases (shaded areas)

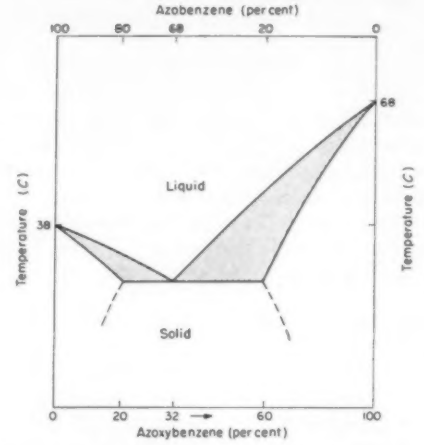


Fig. 6—Phase diagram representative of two-constituent compounds that are soluble while in the liquid phase. Shaded areas represent liquid plus solid phases.

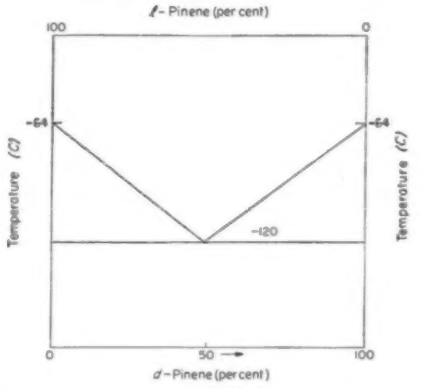


Fig. 7—Phase diagram for compound with no solubility in solid phase.

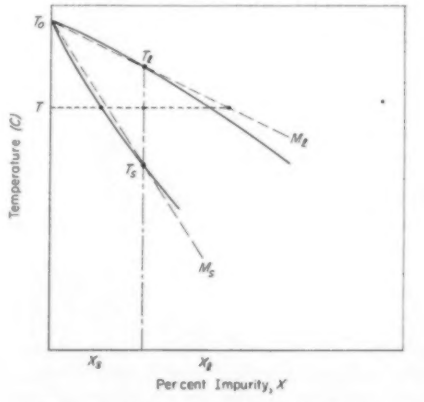


Fig. 8—Approximation of phase diagram by straight lines.

are relatively narrow. Thus, there will be a narrower temperature range in which the bellows will complete its full travel.

In Fig. 7, a system is shown for which there is no solubility in the solid phase.[5] This is the worst situation, for it can be shown that in a control with $\alpha = 50$ per cent large changes in temperature are required before the bellows will move through its full travel. For example, if the impurity (l-pinene) is 5 per cent, the melting point is depressed only 6.4 degrees (C), while the control range is 50 degrees wide.

The designer will need to know how the bellows moves as a function of temperature. This expression can be derived if a few points on the phase diagram in the region in question are known. Fig. 8 is a typical example where straight lines are used to approximate the solidus and liquidus. Melting point T_o of the pure compound may be used, and the points T_s and T_l may be determined by experiment. This derivation treats the case for small impurities, but other cases, such as those near a eutectic region, can be handled in an analogous manner.

Let the slopes of the approximate lines be M_s and M_l. These lines have the equations

$$T = M_l X_l + T_o$$
$$T = M_s X_s + T_o \qquad (8)$$

Now, if the lever rule is applied, the percentage liquid existing at temperature T may be found. It is this change of solid to liquid that causes the bellows to move proportionally by some factor K, or

$$y = K \frac{X - X_s}{X_l - X_s} \qquad (9)$$

Table 2—Fusion Characteristics of Two-constituent Compound

Azoxybenzene in Mixture X (per cent)	Melting Range $T_l - T_s$ (C)	Melting Point Depression $T_o - T_l$ (C)
1	0.10	0.70
5	1.25	2.40
10	1.70	5.30
20	3.20	10.60

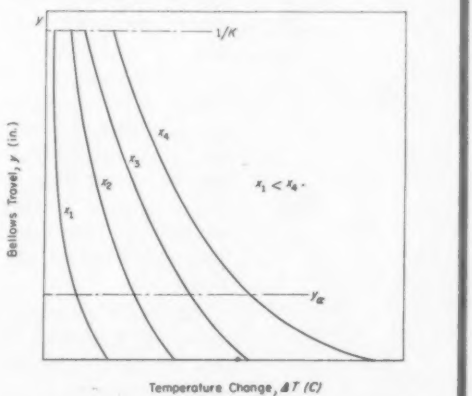


Fig. 9—Bellows travel as function of ΔT (Equation 10).

By substituting Equation 8 into 9, an expression for the bellows travel y can be found. If this equation is nondimensionalized, it will have the form

$$y = A + \frac{BX}{\Delta T} \qquad (10)$$

where the variables have the values

$$\Delta T = T_o - T$$

and the constants have the values

$$A = \frac{K}{1 - \left| \frac{M_s}{M_l} \right|}$$

and

$$B = \frac{K}{1/M_s - 1/M_l}$$

This function can be represented by a family of equilateral hyperbolas plotted in Fig. 9. In the domain

$$X_s \leq X \leq X_l$$

the value of y lies in the region

$$o \leq y \leq 1/K$$

Finally, if α is set at some particular value,

$$\frac{2X}{1/M_l + 1/M_s} < \Delta T_\alpha < (T_o - T_l) \qquad (11)$$

and there is a lower bound for $y = y_\alpha$.

When complete phase separation occurs, such as that shown in the diagram of Fig. 7, the value of y may be found by noting that

$$\text{Limit } y = \frac{KM_lX}{\Delta T}$$
$$M_s \to \infty$$

The explanation of Fig. 9 is simple enough. As more impurity is introduced into the compound of the control, the bellows will move during a greater range of temperature changes. The line $1/K$ is the liquidus condition on the phase diagram, and the line y_α is the condition where the bellows begins to move. If more compound is used—that is, V is increased—and α is also increased, the line y_α can be raised. This will offset the range of melting that would be incurred by adding impurity.

An example will now be given for the system shown in Fig. 6. Assuming that the azobenzene is the primary constituent the following data can be found: $T_o = 68$ C; $M_l = 53.2$ C per mole fraction; and $M_s = 88.3$ C per mole fraction.

Let $\alpha = 50$ per cent and $K = 1$. Then substituting these factors into Equation 10 gives the results of Table 2. It is seen that the melting range is not so severe as in example given for the d-pinene system.

Not all phase diagrams will be as simple as the examples included here. However, these few suggestions may spur wider application of this phenomenon in many fields of temperature control.

References

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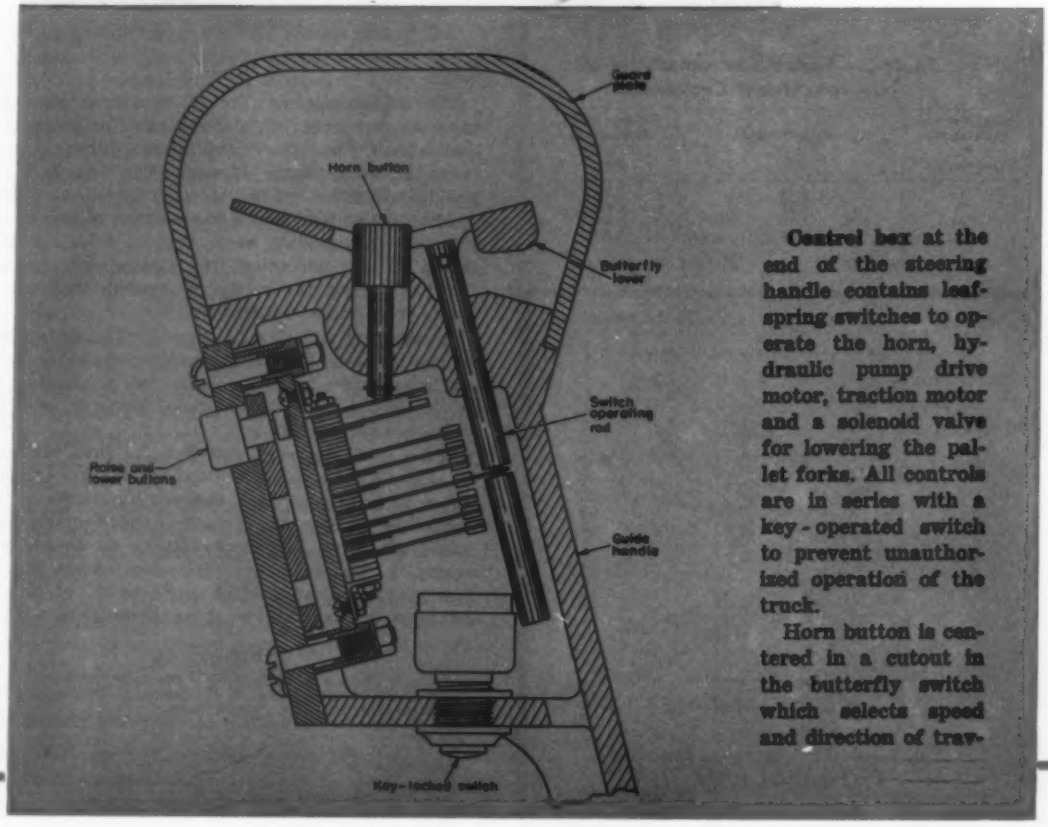
2. G. W. McKee—*Thermostatic Control, Patent* 1,884,794, Oct. 25, 1932.
3. N. I. Sax—*Handbook of Dangerous Materials*, Reinhold Publishing Corp., N. Y.
4. J. H. Hildebrand and R. L. Scott—*Solubility of Nonelectrolytes*, Reinhold Publishing Corp., N. Y.
5. S. Glasstone—*Textbook of Physical Chemistry*, D. Van Nostrand, N. Y.

ALL PALLET TRUCK CONTROLS IN HANDLE

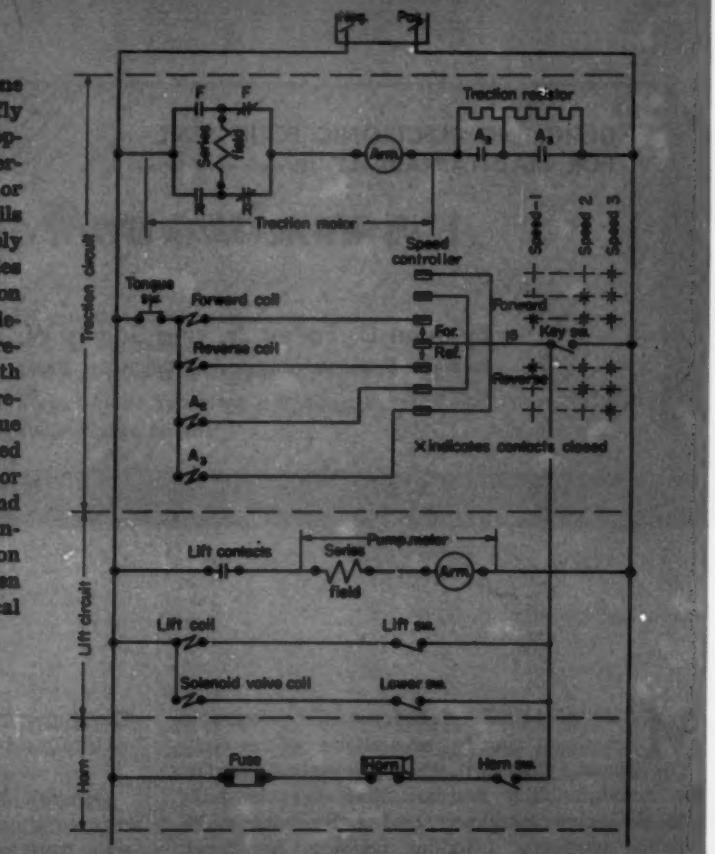
ALL controls of a recently introduced pallet truck are conveniently grouped on or operated by the steering handle. Produced in 4000 and 6000-lb capacity models by the Automatic Transportation Co., these new Transporters are only 21½ in. long, excluding the pallet forks. Controls conveniently located on the handle include a horn button, pallet lowering and raising pushbuttons and a forward - reverse and speed-selector switch. Three speeds are available for reverse as well as forward travel.



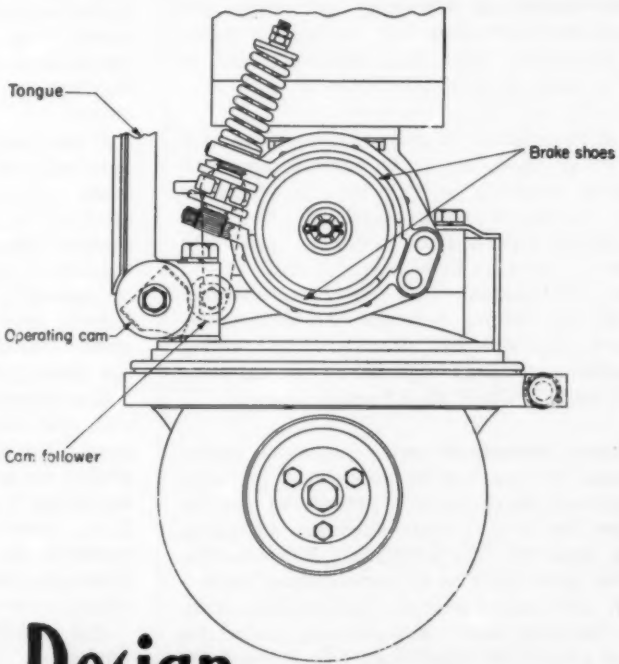
Control box at the end of the steering handle contains leaf-spring switches to operate the horn, hydraulic pump drive motor, traction motor and a solenoid valve for lowering the pallet forks. All controls are in series with a key - operated switch to prevent unauthorized operation of the truck.

Horn button is centered in a cutout in the butterfly switch which selects speed and direction of trav-

el. Depressing one wing of the butterfly moves the switch operating rod to energize either forward or reverse contact coils and appropriately connect the series field of the traction motor. Degree of depression controls resistance in series with the motor and thereby speed. Tongue switch is controlled by steering handle or tongue position and automatically de-energizes the traction motor circuit when the handle is vertical or horizontal.



Spring applied brake is released by a cam and follower when the tongue is in travelling position. When the tongue is in either a vertical or horizontal position, brakes are applied by the spring. Brake is of the external-contracting type. Brake drum is mounted on a shaft in the reduction gear train between motor and drive wheel.



Contemporary Design

DESIGNING ELECTRONIC EQUIPMENT FOR MAINTAINABILITY *(Eleventh of a Series)*

A systematic approach to preparing

By John D. Folley Jr. and James W. Altman
Research Scientists, American Institute for Research, Pittsburgh

MAINTENANCE procedures for electronic equipment specify the activities of the technician. Therefore, they indirectly determine the maintainability features that must be built into the prime equipment and any needed maintenance supports including training, personnel, etc.

Poorly "designed" maintenance procedures can offset the benefits of otherwise good design for maintainability. Delaying preparation of maintenance procedures until after the equipment is designed is likely to yield poor maintainability.

Types of Procedures: In general, procedures may describe every operation to be carried out, with no decisions required, or may include a number of choice points requiring decisions. The best compromise for a particular procedure is primarily a function of the task to be accomplished.

Routine replacement and repair procedures usually do not require decisions. Trouble-shooting procedures, however, usually must contain some decisions. Sometimes a set of general rules or principles is better than a fixed procedure.

Procedures Needed: Every maintenance operation should be specified in procedures prepared during system development. Procedures are required for checking, trouble shooting, adjusting, replacing, repairing and servicing. Recommendations given here apply at all maintenance levels—customer, field and factory—plus periodic maintenance. Checking and trouble-shooting procedures should be given most attention. These two functions of maintenance take a large part of technicians' time.

Specific recommendations are given in this article for checking and trouble-shooting procedures. The same general characteristics also apply to the other four functions just mentioned.

General Recommendations: Maintenance procedures should always be made as brief as possible without sacrificing necessary information. Procedures can sometimes be shortened by including certain steps that achieve the same result as several other steps. For example, instead of checking two independent outputs, check a third output that makes use of the first two. If it is in tolerance, the other two must also be in tolerance.

A procedure must give results that are as foolproof as possible. For example, if a properly performed check procedure yields an in-tolerance indication, the technician must be certain that the checked components are actually operating within tolerance. It is unlikely that many checks used in electronic maintenance give "certain" results, but the procedure should be such that out-of-tolerance conditions will almost always be found by the check procedures.

Procedures should always be in line with the skill and knowledge levels of the technicians who are to follow them. Concepts should be kept as simple as practical. Simplicity of concepts may be strongly influenced by equipment complexity if the technician must memorize any of them to perform the procedure. Procedures may sometimes be simplified by designing the test equipment to do some or all of the programming.

The number of decisions required should be minimized. A greater number of decisions means, in general, a more difficult task for the technician. Eliminating too many decisions, however, may make a procedure so long and time consuming that the inclusion of some decision making would be

Maintenance Procedures

The importance of good maintenance procedures and how they can influence design of electronic equipment are considered in this article. Recommendations are given for developing procedures for checking, trouble shooting, adjusting, replacing, repairing and servicing equipment.

an improvement. Obviously, when the procedures are prepared, it must be decided which approach will be of greatest aid to the technician.

Decisions required in a procedure should also be made as simple as practicable. Decisions are simplified when the number of alternatives is minimized, and when the number of contingent conditions for selection of an alternative is reduced.

The amount and variety of test equipment required by a procedure should be kept to a minimum. A wide variety of test equipment requires a greater breadth of skill and knowledge on the part of the technician.

An exact step-by-step procedure is easiest to follow. New personnel will learn a procedure faster if the sequence is practically invariant than if it changes from one time to the next.

Procedures should not only specify how to start up equipment but how to shut it down. Otherwise the equipment may be left in a condition that is likely to cause accidents or shorten operating life of equipment.

Procedures should not require the technician to work near dangerous voltages or delicate components unless absolutely necessary.

Servicing procedures usually should not make it necessary to dismantle equipment. Most of the servicing should be performed through accesses.

Trouble-Shooting Procedures: It is especially important that systematic trouble-shooting procedures[1,2] be provided. Inefficient or even dangerous practices may be followed if efficient procedures are not provided. Systematic trouble shooting should proceed in three phases:

1. Routine check of system to identify or verify malfunction symptoms.
2. Symptom-pattern analysis to narrow the area

Table 1—Typical Routine Check* for Systematic Trouble Shooting

1. **Radar-Set Check**
   - 1.1 Power-Supply Checks
     - 1.1.1 DC Regulated Voltage, +300v
     - 1.1.2 DC Regulated Voltage, +150v
     - 1.1.3 DC Regulated Voltage, −150v
     - 1.1.4 Repeller Voltage
     - 1.1.5 AC Power Bus
     - 1.1.6 Relay Supply DC Voltage
   - 1.2 Transmitter-Output Checks
     - 1.2.1 Frequency
     - 1.2.2 Frequency Spectrum
     - 1.2.3 PRF
     - 1.2.4 Shape of Modulation Envelope
     - 1.2.5 Power Output
   - 1.3 Receiver Checks
     - 1.3.1 Sensitivity
     - 1.3.2 Output
     - 1.3.3 AFC
2. **Search-Mode Operational Checks**
   - 2.1 Antenna Search Pattern
     - 2.1.1 Narrow Pattern (right and left)
     - 2.1.2 Wide Pattern (center)
     - 2.1.3 Antenna Spin Pattern
   - 2.2 Display Calibration
   - 2.3 Artificial Horizon
3. **Manual Track Operational Checks**
   - 3.1 Antenna Control
   - 3.2 Manual Track Test
   - 3.3 Lock-on
     - 3.3.1 Sensitivity of Lock-On
     - 3.3.2 Display Function
4. **Auto Track Operational Checks**
   - 4.1 Attack Phase Operational
   - 4.2 Rocketfire
   - 4.3 Pull-Out Warning
5. **Miscellaneous Checks**
   - 5.1 Antenna Table Dither
   - 5.2 Radar Antijam Control Operation
   - 5.3 Pilot Scope Controls

*This is an outline of steps for a preflight check of fire-control system. It is presented to show how a routine check can be used in designing aids for systematic trouble shooting.

1. R. B. Miller, J. D. Folley Jr., and P. R. Smith—"Trouble Shooting in Electronics Equipment—A Proposed Method," American Institute for Research, Pittsburgh, March, 1953.

2. R. B. Miller, J. D. Folley Jr., and P. R. Smith—"Systematic Trouble Shooting and the Half-Split Technique," *HRRC Technical Report* 53-21, Human Resources Research Center, San Antonio, Texas, July, 1953.

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of malfunction.

3. Special checks to isolate the malfunction to a replaceable or repairable unit.

Routine Checks: These are checks that are regularly used to determine whether electronic equipment or a prescribed portion of equipment contains a malfunction. An example of a routine check is shown in Table 1.

Trouble shooting will usually begin with a routine check. It will tell the technician that a malfunction is present within the system and will provide information as to where within the system the malfunction is located. This information is in the form of a pattern of malfunction symptoms. Analysis of these symptoms by means of a list, such as shown in Table 2, may eliminate the need for certain special checks.

Symptom-Pattern Analysis: One way to help the technician analyze symptom patterns is to provide him with special system diagrams. These diagrams would indicate which components affect each system output for each step of the routine check procedure. For each step, the components that have come into operation and have gone out of operation since the previous step should be indicated. From this information the technician can "figure out" which components could be causing a certain pattern of symptoms. However, it is usually better to tell the technician what components could be causing the symptoms. This can be done by providing him with a diagram for each symptom pattern, showing the data flow among possible malfunctioning components and/or a list of possible malfunctioning components for each symptom pattern.

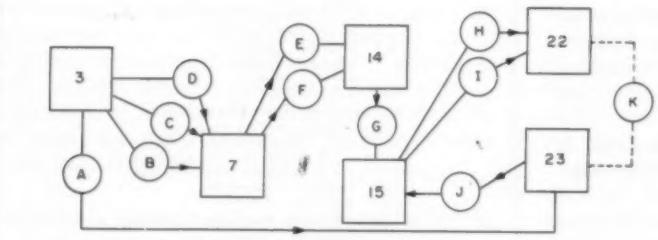
The number of possible patterns observable from n mutually exclusive symptoms is $2^n - 1$, and becomes quite large even with a moderate number of possible symptoms. Thus for 10 symptoms there are 1023 patterns. Providing analyses for this many patterns is impractical, and they will be of little use in the field.

There are two major ways of reducing the number of different patterns that must be analyzed. Both involve working with groups of symptoms and both will not, usually, make full use of the information available from the routine check.

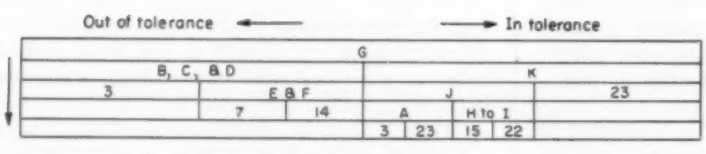
The first way is to combine a number of individual symptoms into a single group symptom. The group symptom is considered to have occurred if any of the individual symptoms in the group occurs. A diagram, Fig. 1*a*, is then prepared for each pattern of group symptoms showing the data flow among all of the components in which a malfunction could cause the observed pattern of group symptoms. No information available from the routine check is lost by this method when the same components could cause all of the individual symptoms in a particular group.

The second way to reduce the number of symptom patterns is to divide the individual symptoms into groups and then prepare a diagram only for each within-group symptom pattern. Thus, if nine symptoms were divided into three equal groups as done in Table 3, the designer would prepare $2^3 + 2^3 + 2^3 - 3$ or 21 different diagrams instead of the 2^9-1 or 511 diagrams for all possible patterns for individual symptoms. No information available from the routine check is lost by this method when no component could cause symptoms in more than one group.

Special Checks: The technician should be provided with aid in choosing the best sequence of special checks to use after the symptom pattern has been analyzed. Usually the sequence of checks should be flexible, with the exact sequence de-



(a) Signal Flow Diagram



(b) Sequence of Checks

Fig. 1—In *a* is a signal flow diagram in an electronic fire-control system for trouble shooting symptom pattern condition of 2.1 = X, 2.2 = O, and 2.3 = O in Table 2. The squares are customer-replaceable units in the equipment and the circles are test points. A chart for a flexible yet efficient sequence of checks for this symptom pattern is shown in *b*. Checks are made starting with the top line first. If all are *in-tolerance*, checks are made in box immediately below and to the right. If any signal or other condition is *out-of-tolerance*, checks are made immediately below and to the left.

pending upon where malfunction symptoms are observed. There is one exception. An inflexible order of checks can be specified where the time required for a particular sequence is likely to be small. This is usually the case only in trouble shooting to parts after a malfunction has been isolated to a particular stage of equipment.

Prescribe a sequence of checks such that the malfunction is first isolated to a single series chain. The best check to make first in isolating the trouble to a particular chain is at the terminal output of the chain where the probability of observing the malfunction in that check divided by the time required to make the check is a maximum. Three considerations are relevant here: (1) the "series chain" may have a number of branches contributing to its final output; (2) the probability of the malfunction being in a given chain may be determined from data on the frequency of malfunctions, or may be based simply upon the number of components in the chain; (3) the time required to perform certain checks may have to be estimated.

Once a malfunction has been isolated to a single chain, the best procedure is to check at the point in the chain where the probability of observing a malfunction is closest to one-half[2]. The checking sequence is affected, however, by the time required to make the various checks. It may be desirable to make the least time-consuming checks first even though they may not adhere to the principle of one-half probability just outlined. It may also be desirable to delay checks of components in feedback loops if the time required to break the loop for checking is appreciable.

Provide the technician with appropriate signal flow diagrams, Fig. 1*a, and* a table or chart for each symptom pattern giving the most efficient sequence of checks. The chart in Fig. 1*b* illustrates a flexible order of checks that depends upon whether or not an out-of-tolerance indication is obtained at each point. The first check that should be made if a given symptom pattern is observed is represented by *G*. The letters *B*, *C*, *D* or *K* represent alternative checks following *G*, and so on. Choose the next alternative to the *left* following an out-of-tolerance indication, and the one to the *right* following an in-tolerance indication.

Table 2—Typical Malfunction Symptom-Pattern Chart*

Symptom Pattern			Trouble-Shooting Directions
1.1	1.2	1.3	
X	O	O	Do not run test 1.2 and 1.3 until power supply is adjusted correctly or replaced
O	X	O	Use signal flow diagram 1*a* for trouble shooting
O	O	X	Use signal flow diagram 1*b* for trouble shooting
O	X	X	Use signal flow diagram 1*c* for trouble shooting
2.1	2.2	2.3	
X	O	O	Use signal flow diagram 2*a* for trouble shooting
O	X	O	Use signal flow diagram 2*b* for trouble shooting
O	O	X	Use signal flow diagram 2*c* for trouble shooting
X	X	O	Replace master controller (CRU† 7)
O	X	X	Use signal flow diagram 2*d* for trouble shooting
X	O	X	Replace master controller (CRU 7)
X	X	X	Replace master controller (CRU 7)
3.1	3.2	3.3	
X	O	O	Use signal flow diagram 3*a* for trouble shooting
O	O	X	Use signal flow diagram 3*b* for trouble shooting
X	X	O	Replace master controller (CRU 7)
O	X	X	Use signal flow diagram 3*c* for trouble shooting
X	O	X	Use signal flow diagram 3*d* for trouble shooting
X	X	X	Use signal flow diagram 3*e* for trouble shooting
4.1	4.2	4.3	
X	O	O	Use signal flow diagram 4*a* for trouble shooting
O	X	O	Use signal flow diagram 4*b* for trouble shooting
O	O	X	Use signal flow diagram 4*c* for trouble shooting
X	O	X	Use signal flow diagram 4*d* for trouble shooting
O	X	X	Replace master computer "B" (CRU 13)
X	X	X	Use signal flow diagram 4*e* for trouble shooting
5.1	5.2	5.3	
X	O	O	Use signal flow diagram 5*a* for trouble shooting
O	X	O	Use signal flow diagram 5*b* for trouble shooting
O	O	X	Use signal flow diagram 5*c* for trouble shooting
X	X	X	Check for voltage at main power bus If this checks OK replace pilots control box (CRU 3).

*Symptom patterns obtainable from preflight check obtainable in Table 1 for a fire-control system. A malfunction symptom observed is designated by X and an in-tolerance indication by O.
†CRU means a customer-replaceable unit.

Table 3—Group-Step Symptom Pattern Chart*

Routine Check (Group)	(Step)	Symptom Pattern for Each Step	Symptom Pattern for Each Group
A	1	X	X
	2	X	
	3	O	
B	4	O	O
	5	O	
	6	O	
C	7	O	X
	8	O	
	9	X	

*Absence of a symptom is indicated by O and its presence by X. The total number of possible step patterns is 511. The total number of possible group patterns is 7.

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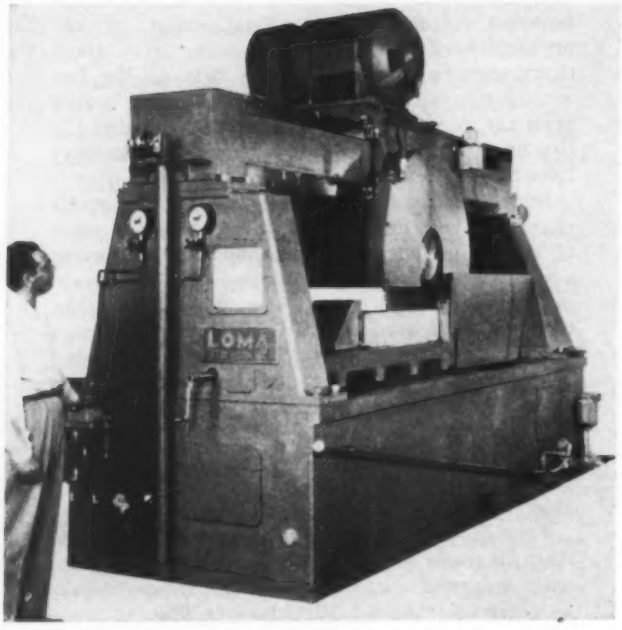
This article is the eleventh in a co-ordinated series by John D. Folley Jr. and James W. Altman. Previous articles, and issues of MACHINE DESIGN in which they appeared are:

Designing Electronic Equipment for Maintainability	June 14, 1956
Units, Assemblies and Subassemblies	June 28, 1956
Covers and Cases	July 12, 1956
Wiring, Cables and Connectors	July 26, 1956
Maintenance Accesses	Aug. 9, 1956
Test Points	Sept. 6, 1956
Controls	Sept. 20, 1956
Displays	Oct. 4, 1956
Equipment Installation	Oct. 18, 1956
Maintenance Auxiliaries	Nov. 15, 1956

". . . it would seem to me to be a relatively safe prediction that in 20 years—barring a world catastrophe—we will need twice as large a fraction of our working force engaged in science, engineering, and medicine as we have today. Maybe it will be 30 years. But the trend is in this direction, and the task will be a gigantic one. We had better explore the possibilities . . ."—DR. LEE A. DUBRIDGE, *California Institute of Technology.*

XUM

Overhead Carriage Protects Saw



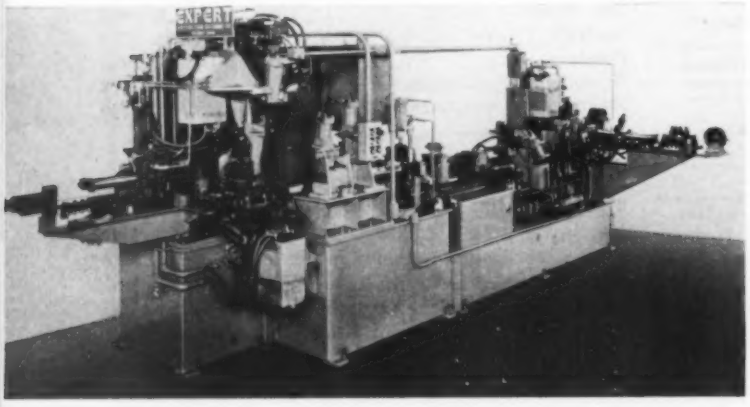
ALL moving parts of a recently announced ingot saw are mounted on an overhead carriage to provide maximum protection for all moving parts such as motor, carriage, blade drive and feed mechanism. This design approach protects all such parts from damage from lubricants and chips. Protection for the operator is also provided in this product of Loma Machine Mfg. Co. Inc. by placing remote controls for all adjustments and operations on the outer end of the machine. This places a wide cross-beam support between the saw and the operator. A window in the support allows the operator to observe the cutting process.

Contemporary Design

Machine Automatically Makes Wire Baskets

ALL operations necessary to produce a finished wire basket from bulk wire are performed by a new machine which performs a variety of operations. A product of Expert Automation Machine Co., the machine draws five parallel longitudinal wires and cross wires from stationary reels. Wires are straightened before being resistance welded together to form a flat mesh strip from which the rectangular baskets are formed.

As the longitudinal wires are fed in, cross wires are fed at right angles. Cross wires are then resistance welded to the longitudinal wires. During the time they are being welded to the longitudinal wires, the cross wires are sheared from the feed reels. The wire pattern is then advanced the length required for one basket and this length is sheared off. Corners of the cut length of mesh are then cut out to form the basket pattern. Cross wires are then trimmed flush with the outside longitudinal wires. This prepared pattern is then folded and welded into a 4¼ by 7¼ by 4-in. deep basket.



A rapid method

for developing

Cam Profiles

having desired acceleration characteristics

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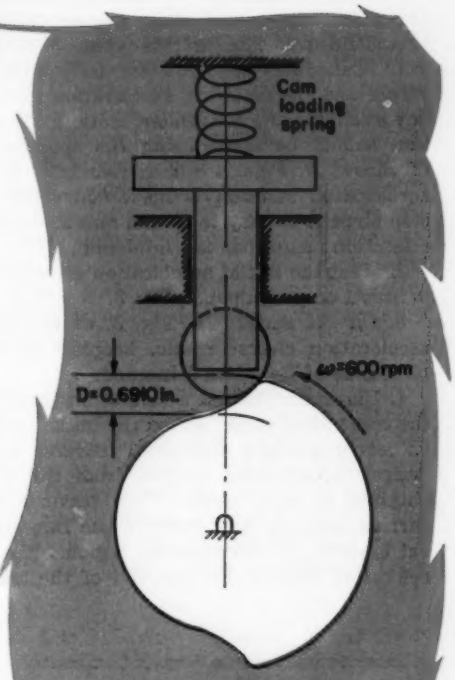


Fig. 1 — Typical spring-loaded cam mechanism.

THE THEORY of finite differenes was suggested in a recent article[1] as a simple and flexible arithmetical method for cam design. With this method, any desired and feasible acceleration characteristic can be obtained by systematically adjusting the follower-body displacement points in a sequential manner to obtain the desired acceleration factor variation. This might be thought of as a whittling process, and the speed of adjustment depends on foresight and ingenuity.

This article presents a method for arriving at the desired acceleration characteristic in only two displacement-adjustment traverses. In effect, the suggested method introduces a positive controlling factor to the whittling process and removes the ingenuity requirement.

Basic Relations: In the movement of a body from one position to another, acceleration, velocity and displacement variations are compatible with each other. For instance, during a given period of time the change in velocity, Δv, must equal the area under the acceleration-time plot:

$$v_2 - v_1 = \Delta v = \int_{t_1}^{t_2} a \, dt \qquad (1)$$

[1]References are tabulated at end of article.

Also, the change in displacement, Δs, during the same interval must equal the area under the velocity-time plot:

$$s_2 - s_1 = \Delta s = \int_{t_1}^{t_2} v \, dt \qquad (2)$$

Combining Equations 1 and 2 results in the following relationship between the change in displacement, initial velocity, and area under the acceleration-time plot:

$$s_2 - s_1 = \Delta s = \int_{t_1}^{t_2} \left(v_1 + \int_{t_1}^{t} a \, dt \right) dt \qquad (3)$$

Development of Desired Acceleration: A common problem is the development of a profile which has special acceleration characteristic and, yet, imparts to the follower a specified amount of throw. It is the combination of these necessarily compatible requirements which makes the uncontrolled, successive-traverse method sometimes difficult. Hence, the following method has been developed as a rapid process for arriving at a desired acceleration characteristic. The outlined method assumes that the follower body starts and ends its motion in a state of zero velocity (dwell-rise-dwell). Figs.

1-4, which contain the details of a numerical example to be presented later, are also referenced in the outlined method at this point. The steps are:

1. Calculate the follower-body displacement values and the resulting acceleration factors, using any available and convenient motion. This calculation should be made using the specified amount of throw, D, Figs. 1 and 4. Generally a constant-acceleration solution is most convenient for this step since it is easy to obtain and the resulting acceleration magnitude is a minimum.

2. Plot the initial acceleration factors calculated in Step 1 on graph paper, Fig. 3.

3. On the same plot, Fig. 3, sketch the *desired* acceleration characteristic, keeping the area implications of Equation 3 in mind.

4. Using the desired acceleration factor curve as the controlling guide, adjust the initial displacement values in a single sequential traverse so that the desired acceleration factors from the sketch are obtained at each point. This traverse should be carried through, and possibly one cam-angle interval beyond, the development region. The large acceleration resulting at the end of the traverse but outside of the development region will not matter, since it will be eliminated by the next step. Step 4 is guided by the desired acceleration characteristic sketched in Fig. 3 and the single traverse is shown in the third column of Fig. 2.

5. The adjusted displacement values from Step 4 will generally differ appreciably from the initial values calculated in Step 1. In fact, unless the designer is unusually fortunate, the throw after Step 4 will differ appreciably from the desired throw, D, by an amount which will be called h. For Step 5, *change* each of the adjusted displacements existing after Step 4 by an amount equal to $h/(D + h)$ times the adjusted displacement. Generally this *change* can be computed accurately enough on a slide rule. Incidentally, h will be considered as positive if the throw after Step 4 is greater than the desired throw, D, and negative if that throw is less than D. Changing each of the displacements by this factor will result in the correct total throw and the desired acceleration characteristic will be retained. In effect, Step 5 proportionately compresses (or expands) the displacements to give the correct throw without changing

Fig. 2—Calculation sheet for developing a cam profile having a desired acceleration characteristic.

Cam Angle θ (deg)	Displacements, s (inches x 10^4)				Acceleration Factors ($s_1 + s_2 - 2\,s_0$)			
	Initial (from constant-accel. solution) (Step 1)	Adjustments dictated by desired accel. sketch of Fig. 3 (Step 4)	Change for obtaining correct throw (Step 5)	Total (Step 8)	Initial (Step 1)	Corrected for desired shape (Step 4)	Corrected for correct throw specification (Step 6)	Calculated from total displacements (check) (Step 8)
0	0	—	0	0	+12	+4		+4
1	12	-8	0	4	+24	+10 +17	+16	+16
2	48	-23	-1	24	+24	+16 +62 +24	+26 +22	+22
3	108	-38	-4	66	+25	0 + 76 + 28	+27 +35 +27	+27
4	191	-48	-8	135	+25	-18 +83 +30	+26 +42 +28	+28
5	299	-53	-14	232	+25	-25 +81 +32	+24 +52 +31	+31
6	430	-49	-21	360	+25	-28 +70 +32	+18 +60 +29	+29
7	586	-38	-31	517	+25	-26 +50 +32	+11 +73 +31	+31
8	765	-18	-42	705	+24	-14 +22 +31	0 + 84 +30	+30
9	968	+9	-54	923	+25	+7 -11 +30	-12 +96 +27	+27
10	1196	+41	-69	1168	+23	+32 -50 +28	-26 +112 +27	+27
11	1447	+78	-85	1440	+24	+65 -91 +25	-44 +126 +23	+23
12	1722	+116	-103	1735	+23	+101 -131 +22	-63 +143 +22	+22
13	2020	+153	-121	2052	+25	+141 -165 +19	-84 +158 +17	+17
14	2343	+184	-141	2386	+24	+177 -191 +15	-106 +176 +15	+15
15	2690	+206	-161	2735	+23	+207 -205 +10	-131 +191 +8	+8
16	3060	+215	-183	3092	+25	+231 -199 +5	-156 +210 +6	+6
17	3455	+204	-204	3455	0	+215 -193 0	-183 +225 0	0
18	3850	+193	-225	3818				

the general shape of the desired acceleration characteristic. The displacement corrections are illustrated in the fourth column of Fig. 2.

6. In a single sequential traverse, correct the acceleration factors to agree with the displacement corrections just made in Step 5.

7. Plot the acceleration factors from Step 6 on the same graph, Fig. 3. The acceleration factors from Step 6 should be very similar to the desired acceleration variation sketch.

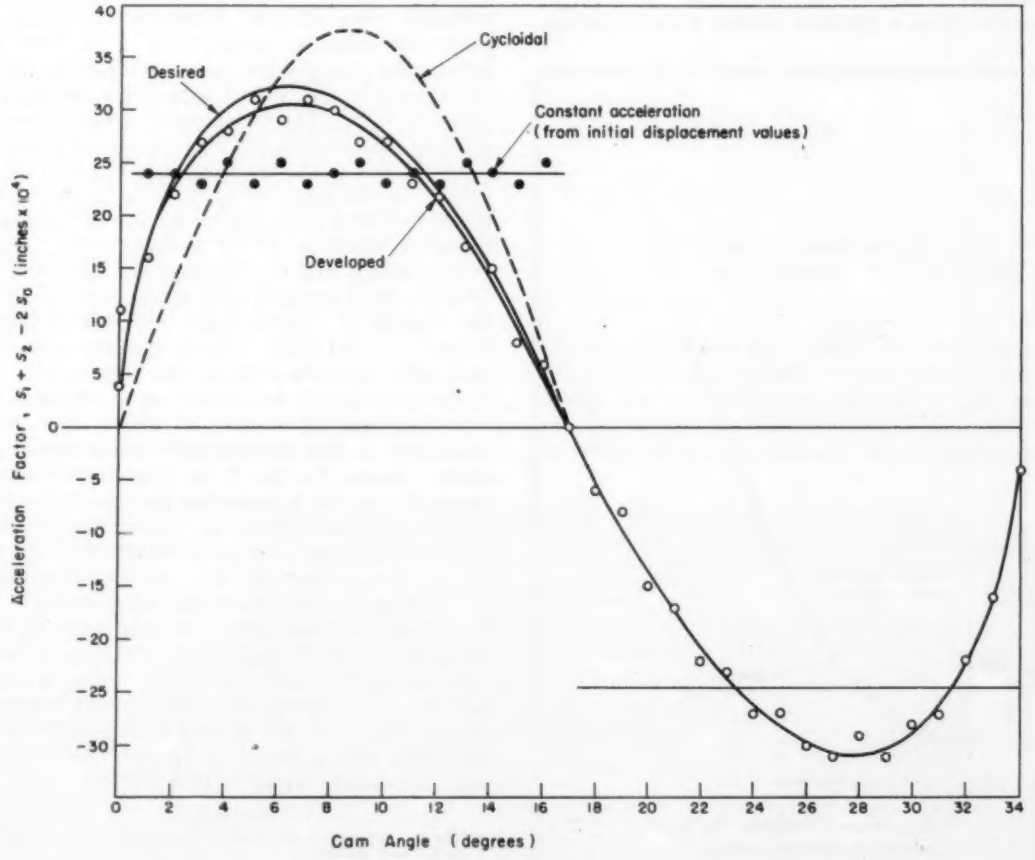
8. Calculate the total displacements at each point merely by summing the initial displacement with the corrections made in Steps 4 and 5. Using these total displacement values, calculate the acceleration factors at each point. If no mistakes have been made in the development process, these acceleration factors should agree exactly with the acceleration factors obtained at the end of Step 6. Step 8 merely serves as a check on the accuracy.

In the method just outlined, it was assumed that the follower body started from rest and ended at rest. The motion was developed to satisfy a specified throw and a desired acceleration characteristic.

Other types of problems can be attacked in a similar manner. For instance, if the initial and final velocities were specified as values other than zero, and if a particular acceleration characteristic were desired, then a very similar method can be used. The desired acceleration sketch would be made on the initial acceleration plot as before, but Equation 1 would then be kept in mind for its area implications instead of Equation 3 as before. Also, the expansion or compression of displacements corresponding to Step 5 would be made using a velocity factor deviation proportionality term instead of the displacement deviation proportionality term, $h/(D + h)$.

Example: Suppose a cam mechanism is to drive a follower body from one position to another during 34 degrees rotation of the cam. Assume that the cam will rotate at a constant velocity of 600 rpm and that the follower body is initially and finally in a state of rest. The mechanism is to be spring loaded as illustrated in Fig. 1 and the total throw is to be 0.6910-in. Assume that the follower body

Fig. 3—Comparative plot of acceleration curves.



displacement values can be held to a point-to-point variation of 0.0003-in. due to machining errors on the cam surface.

A constant-acceleration solution to the problem gives a maximum acceleration of 31,000 in. per sec^2. A cam angle interval of $\Delta\theta = 1$ deg gives an average acceleration deviation[1] due to machining tolerances of $a_t = \pm 144\ (\omega/\Delta\theta)^2\ t = \pm 144$ (600/1)^2 (0.0003) $= \pm$ 15,6.00 in. per sec^2. As- (600/1)^2 (0.0003) $= \pm$ 15,600 in. per sec^2. Asable value which the designer feels can exist.

Assuming that the motion will be entirely symmetrical, the development needs only to be carried out for 17 deg of cam rotation, since the remaining 17 deg will be similar. The initial follower-body displacement values are calculated for a constant acceleration type of solution. These values and the calculated acceleration factors are given in Fig. 2 (Step 1 columns) and Figs. 3 and 4.

The desired acceleration factor is sketched on Fig. 3. The desired variation differs appreciably from both the constant-acceleration solution and the cycloidal solution which is also outlined on Fig. 3. The desired variation is smooth, low in magnitude and displaced in a sidewise direction from the cycloidal variation.

It is well known that acceleration smoothness is a highly desirable characteristic from a vibrational standpoint. Likewise the low magnitude is highly desirable from a follower contact force consideration. The sidewise displacement of the acceleration characteristic is selected for the following reason:

The maximum acceleration for the desired characteristic occurs early in the follower-body displacement motion. Hence, if a proper gradient is chosen for the cam loading spring, the maximum acceleration will occur at a point where the spring deformation and, hence, the spring force is low in magnitude. Therefore, the maximum cam-to-follower contact force will be lower than if the maximum acceleration occurred at a point where the spring was compressed more. In the decelerating region, a sidewise acceleration displacement is also desirable since then the maximum deceleration occurs later in the stroke, at a point closer to where the maximum spring force exists. Also, a smoother cam-to-follower contact force variation results from the desired acceleration variation sketched in Fig. 3. Inclusion of the spring force variation accounts for this result, as illustrated in a previous article.[2]

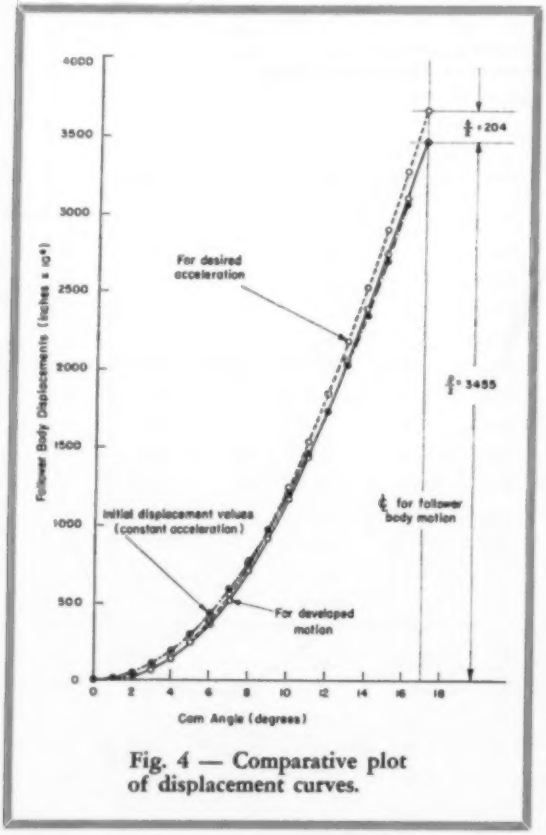


Fig. 4 — Comparative plot of displacement curves.

The next step involves adjusting the follower body displacements in order to obtain the acceleration-factor variation corresponding to the desired curve sketched in Fig. 3. In Fig. 2 the displacement values are adjusted in sequential order from 0 to 18 deg (Step 4), the adjustment being made according to the demands of the desired acceleration factor of the previous point. For instance, the 1-deg displacement value is adjusted by -8 since this adjustment changes the acceleration factor of the 0-deg point to the desired value from the sketched curve of $+4$. Likewise, the 2-deg displacement value is adjusted by -23 since this adjustment changes the acceleration factor of the 1-deg point to the desired value from the sketched curve of $+17$. The displacement adjustments are made in that manner down to the 18-deg point.

At the end of the traverse, it is noticed that the actual displacement of the 17-deg point is now 0.3455 $+0.0204 =$ 0.3659-in. instead of the desired throw of 0.3455-in. at the halfway point. Hence, $D/2 =$ 0.3455 and the displacement deviation, $h/2$ $=$ 0.0204-in. Therefore, each displacement point will be *changed* by a factor equal to 0.0204/(0.3455 + 0.0204) $=$ 204/3659. These *changes*, calculated on a slide rule, are given in Fig. 2 (Step 5).

The next step is to correct the acceleration factors then existing as the last values after Step 4 according to the displacement adjustments just made. Hence, for the 2-deg displacement adjustment of -1, the acceleration factors of the 1-deg and 3-deg points change by -1, and the acceleration factor of the 2-deg point changes by $-2\ (-1)$ $=$ 2. The acceleration factors are corrected by considering the displacement adjustments (Step 5 column) in a sequential manner, starting from the 0-deg to the 18-deg points. The final acceleration factors then exist as the last values in Step 6, and they are plotted as the developed characteristic in Fig. 3. It can be seen from Fig. 3 that the developed characteristic agrees very well in shape with the desired characteristic sketch.

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Servomotors
Preamplifiers
Transducers
Feedback Elements

Hydraulic Servo Components—2

. . . their effect on system performance

By J. M. Nightingale
Manchester, England

AUTOMATIC-control or servo systems are only as effective as the various components making up the system. Nomenclature and details of basic system components, Fig. 12, are covered in this article. Input elements, error detectors, valve amplifiers and power supplies were covered in Part 1.

Servomotors: Hydraulic servomotors are substantially pumps in reverse. In fact most hydraulic pumps could, with a few modifications to valve timing and so on, be run as motors. Where a linear output displacement is required, either a rotary motor driving through worm gearing, or a linear displacement motor—a piston-type hydraulic cylinder—can be used. Cylinders are usually of the double-acting variety, Fig. 13. Neglecting leakage and compressibility, flow characteristic for this cylinder is

$$Q = A\left(\frac{dy}{dt}\right) \tag{8}$$

or in terms of transformed quantities

$$y(s) = \left(\frac{1}{As}\right) Q(s) \tag{9}$$

where Q = flow into cylinder, y = piston displacement, A = piston area, and s = Laplace operator.

For a rotary motor, similarly

$$Q = 2\pi V_m \left(\frac{d\theta}{dt}\right) \tag{10}$$

or by Laplace transformation

$$\theta(s) = \frac{1}{2\pi V_m} Q(s) \tag{11}$$

where θ = angular displacement of motor shaft and v_m = volumetric displacement of motor per revolution.

Preamplifiers and Transducers: In many medium and high-power hydraulic servos, power needed to displace the controlling element of the main amplifier is very considerable when compared with the power in the error signal. This is particularly

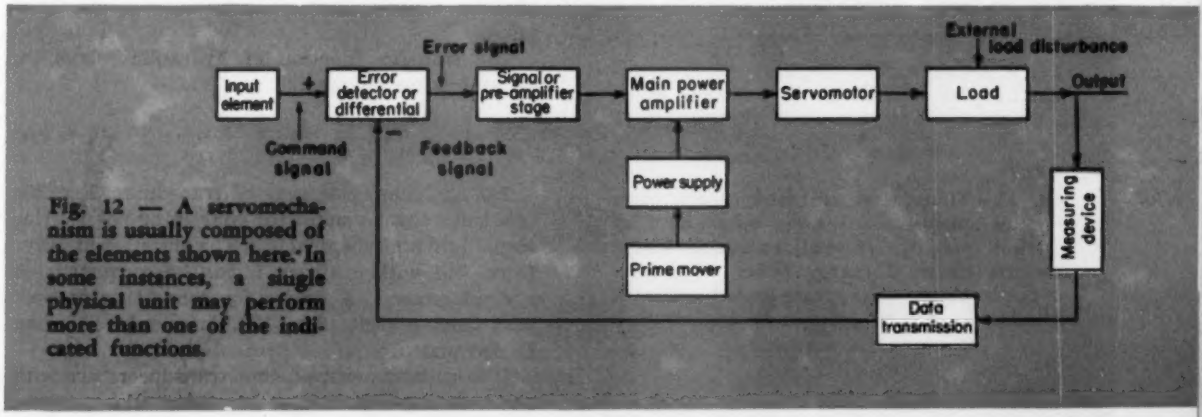


Fig. 12 — A servomechanism is usually composed of the elements shown here. In some instances, a single physical unit may perform more than one of the indicated functions.

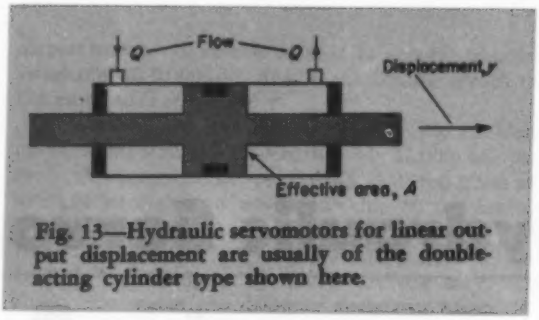


Fig. 13—Hydraulic servomotors for linear output displacement are usually of the double-acting cylinder type shown here.

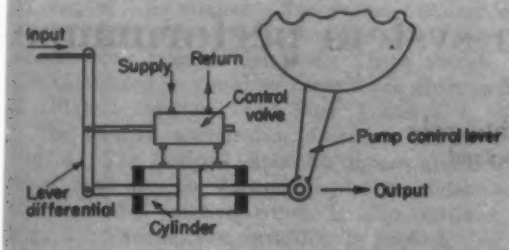


Fig. 14—One type of hydraulic preamplifier is the hydraulic relay consisting of a small control valve and hydraulic cylinder. The hydraulic relay shown here is a closed-loop device controlling a variable-displacement pump.

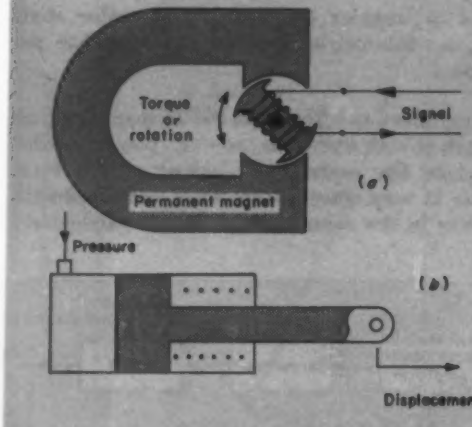
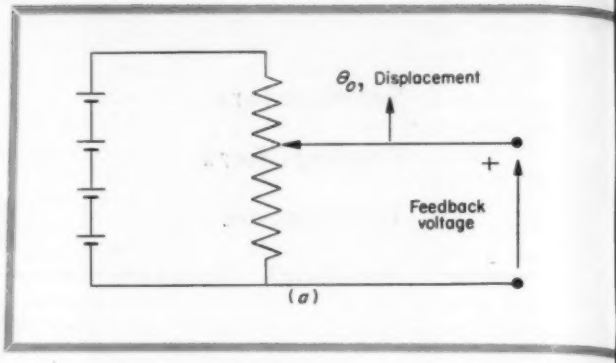


Fig. 15—Transducers are used to convert a physical quantity into some other kind of physical quantity. A small torque motor, *a*, converts electrical energy either to a force or displacement. The spring-loaded hydraulic cylinder, *b*, converts pressure to displacement.



so when the command signal is a low power electrical signal. Therefore, in the low-power end of the servo there is usually a sequence of elements for operating on the error signal. These include preamplifiers for boosting the power to a sufficiently high level and transducers for changing the physical nature of the signal without power amplification, for instance, from a voltage to a displacement and so on. There may also be frequency-sensitive networks for improving the performance of the system.

ELECTRONIC PREAMPLIFIERS: So far as the operating range of most mechanical servos is concerned, electronic preamplifiers have no lags. Therefore,

$$e_o = Ke_i \tag{12}$$

where e_i = input voltage, e_o = output voltage, and K = gain constant.

HYDRAULIC PREAMPLIFIERS: These are pilot valves for operating main valves. They are open-loop amplifiers, often flapper-nozzle valves. They have a transfer function which usually approximates

$$\frac{x}{F}(s) = \frac{K}{1 + Ts} \tag{13}$$

where x = main valve displacement, F = input force, K = gain constant and T = time constant.

HYDRAULIC RELAYS are another type of preamplifier consisting of a small control valve and motor. Usually, they are closed-loop device in themselves, Fig. 14. Here a hydraulic relay is used to operate the control lever of a variable-displacement pump.

The transfer function of hydraulic relays can be approximated by

$$\frac{x_o}{x_i}(s) = \frac{K}{1 + Ts} \tag{14}$$

TRANSDUCERS: One type of transducer, Fig. 15*a*, is a small torque motor for converting an electrical signal into a mechanical one. The output is usually a force, but with a spring it can be converted into a displacement. A device for converting pressure into displacement, Fig. 15*b*, is merely a spring-loaded piston.

It is usually assumed that transducers are without time lags. This is a fair assumption provided

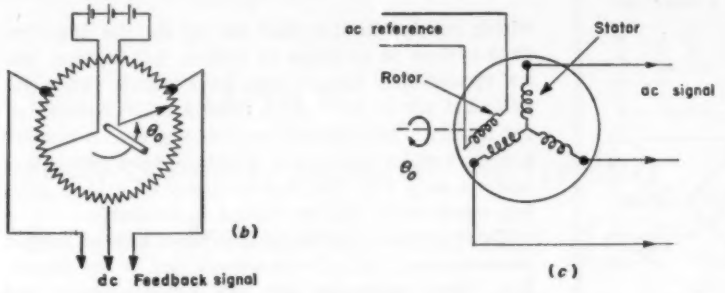


Fig. 16—Measuring devices are used to measure system output. Often they will also convert displacement to a proportional electrical quantity. A potentiometer *a*, dc synchro *b*, and ac synchro *c* are typical of such devices.

the low power side of the servo is only lightly loaded.

Feedback Elements: Measuring devices and data-transmission systems are the usually encountered feedback elements. Measuring devices are used to obtain a measure of the output for feedback. The function of data-transmission systems is to transmit the output signal back to the differential if the two are remote. Occasionally they are used to transmit other signals.

MEASURING DEVICES must be linear and accurate, must not load the output motor and must give signals which can be easily transmitted. Some typical measuring devices, Fig. 16, convert output displacement to a varying voltage or voltages. A number of widely used measuring devices are variable resistors, capacitors or inductors.

DATA TRANSMISSION SYSTEMS may be rods, cables or shafts when the output and input signals are both displacement. Although levers, pulleys and gears can be used to change direction in these mechanical systems, the degree of remoteness of input and output is limited. Some other disadvantages are that operating forces can be high due to inertia and friction. These tend to aggravate inaccuracies due to backlash and flexure. Advantages are that no separable output measuring device is needed. Also mechanical systems can be strong and reliable.

Electrical data transmission systems have obvious advantages where remote control is desired. A big advantage is that only a light load is added to the output motor. In a remote position indicating system which uses a dc synchro, Fig. 17*a*, output position is taken up by a permanent magnet

Nomenclature

A = Area, sq in.
e_i = Input voltage
e_o = Output voltage
F = Input force, lb
K = Gain constant
Q = Flow, cu in. per sec
s = Laplace operator
T = Time constant
V_m = Volumetric displacement of motor, cu in. per rev
x = Valve displacement, in.
x_i = Input displacement, in.
x_o = Output displacement, in.
y = Piston displacement, in.
θ = Angular displacement of motor shaft

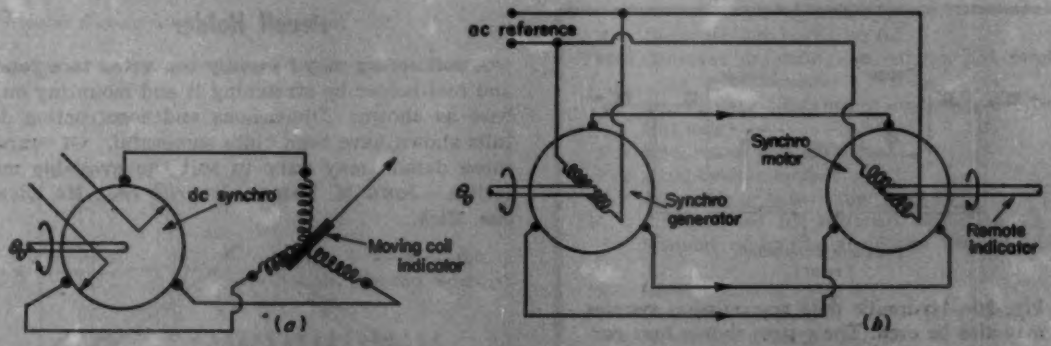
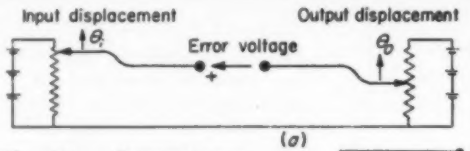


Fig. 17—A dc synchro and moving-coil indicator, *a*, make up a data transmission system, in this instance a remote position indicator. Although accurate, this system can transmit little torque. A similar system using ac synchros *b* has even higher accuracy but again a limited output torque.



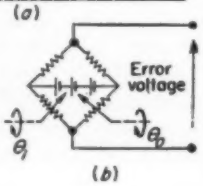


Fig. 18 — Systems combining the functions of output measurement, data transmission and error detection are shown here. System *a* is a potentiometer system. System *b* utilizes the Wheatstone bridge principle.

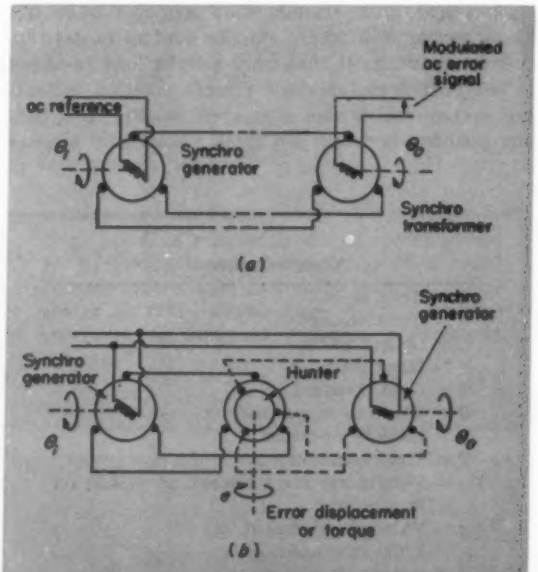


Fig. 19—Functions of output measurement, data transmission and error detection are combined in these systems using ac synchros.

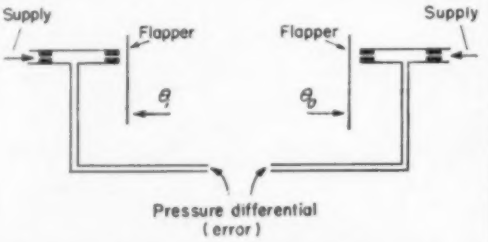


Fig. 20—Hydraulic data transmission systems may also be used. The system shown here corresponds to the Wheatstone bridge circuit of Fig. 18 *b*. Accuracy of this and similar systems is limited because of difficulties in making reliable, linear hydraulic resistors.

which rotates in the field set up by the synchro. This system is accurate to within ±2 degrees, but no appreciable torque can be exerted. Thus its practical use is limited to remote instrumentation, for instance, in a manual-control system. A similar system employing two ac synchros in a generator-motor setup, Fig. 17*b*, has accuracy of ±¼ degree, but again only limited torque is available.

Some systems combine the functions of output measurement, data transmission and error detecting. Two examples are the potentiometer and bridge systems shown in Fig. 18.

Systems employing ac synchros are popular. These can be merely outlined here. A synchro generator and a control transformer give a modulated ac error signal whose amplitude depends on sin $(\theta_i - \theta_o)$, Fig. 19. The system shown in Fig. 19*b* has two generators and a differential motor, called a *hunter*. If the hunter is only lightly loaded it gives a displacement proportional to the error. If the motor shaft is constrained, however, it exerts a torque proportional to the error.

Sometimes hydraulic data transmission systems are used. For instance the system shown in Fig. 20 corresponds to the bridge shown in Fig. 18*b*. The system gives a differential pressure which is proportional to the error. Such systems are of limited accuracy because of the difficulty of making reliable linear hydraulic resistors.

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1. "Automatic Control Systems" .....May 17, 1956
2. "Servo Mathematics" .....June 28, 1956
3. "Evaluating Servo System Performance—Part 1" July 26, 1956
4. "Evaluating Servo System Performance—Part 2" ..Aug. 9, 1956
5. "Analyzing Servo Systems" .....Nov. 1, 1956
6. "Hydraulic Servo Components—Part 1" .....Nov. 29, 1956

Tips and Techniques

Pencil Holder

A coil spring may be easily converted to a pencil and tool holder by stretching it and mounting on a base as shown. Dimensions and construction details shown have been quite successful. Of course, these details may vary to suit the available materials.—JOHN M. BAILEY, *Ironrite Inc., Mt. Clemens, Mich.*

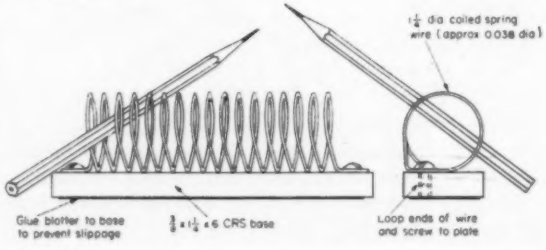
¼ dia. coiled spring wire (approx 0.038 dia.)
Glue blotter to base to prevent slippage
¾ x 1¼ x 6 CRS base
Loop ends of wire and screw to plate

Chart gives transition points between Euler-Johnson curves for

Column Design

By Albert L. Gosman,* Frank R. Campbell and Richard P. Bobco*
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Colorado School of Mines
Golden, Colo.

BUCKLING of a long, slender column under the action of an axial compressive load represents a classic example of elastic instability. Such failure by excessive lateral deflection is not a function of the yield strength of the material. Thus, if the column is long and slender, substitution of a stronger material (higher yield stress) will not necessarily increase the critical or buckling load.

As column length decreases—that is, at low fineness ratios—failure by compressive deformation of the material is a possibility, and yield strength becomes of major importance. In the intermediate range of column lengths, failure by buckling or compression (or both) can occur. Here, the approach to the column design problem is somewhat intuitive, and is usually coupled with experimental verification.

To facilitate design in this latter case, analytical expressions for column stress have been developed that encompass the entire range of lengths—from the very long, elastic member to the very short, compression member. Ideally, these expressions should span smoothly the intermediate range between the two extremes.

Such an expression, first proposed by J. B. Johnson[1], forms the basis of a working chart given in this article which enables the designer to locate the transition points between the Euler and Johnson expressions for a variety of materials and end-fixity conditions. With the transition point fixed, the applicable failure expression is known.

Fundamental Relationships: Critical or buckling load for the fundamental case of a long slender

*Now at Northrop Aircraft Co., Hawthorne, Calif.

[1]References are tabulated at end of article.

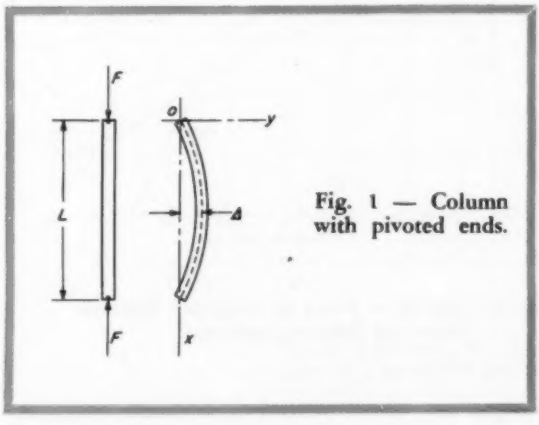

Fig. 1 — Column with pivoted ends.

Nomenclature

A = Cross sectional area, sq in.
C = Constant depending on column end conditions, dimensionless
e = Eccentricity (distance of load from the neutral axis), in.
E = Modulus of elasticity, psi
F = Axial column load, lb
F_a = Allowable or safe column load, lb
F_c = Critical load for incipient deflection, lb
I = Moment of inertia about the neutral axis, in.^{4}
k = Least radius of gyration, in.
L = Length of column, in.
s = Stress due to axial load, psi
s_a = Allowable or safe column stress, psi
s_c = Critical stress, psi
s_y = Elastic limit in compression, psi

column with pivoted ends, Fig. 1, is given by the classical Euler formula

$$F_c = \frac{\pi^2 EI}{L^2} \qquad (1)$$

Assumptions inherent in this relationship are

(*a*) The load is perfectly axial.
(*b*) The column is perfectly straight before loading.
(*c*) The material follows Hooke's law as the limit of the analysis.
(*d*) The material is perfectly homogeneous.
(*e*) The column is of uniform cross-sectional area.
(*f*) Each longitudinal column fiber acts independently from adjacent fibers.
(*g*) The maximum deflection Δ is small.

It is noted that Equation 1 was developed for a column with pivoted ends and length L between points of zero bending moment. This, of course, is only one of a number of possible column end conditions. A few of the other possibilities are: (1) Both ends fixed; (2) One end fixed, one end free; and (3) One end fixed, one end pivoted. Equation 1 may be applied to these cases if an equivalent length L_1 (as a fraction or multiple of L) is selected to correspond to points of zero moment or points of inflection of the elastic curve.

Since the moment of inertia $I = Ak^2$, and $L_1 = CL$, Equation 1 may be rewritten as

$$s_c = \frac{F_c}{A} = \frac{\pi^2 E}{(CL/k)^2} \qquad (2)$$

In design practice, the end conditions are not always ideal. That is, for a column with both ends fixed, $C = 1/2$, indicating a critical load four times as large as that of a column with pivoted ends. Actually, the structure to which the column ends are fixed deflects slightly, thus making C somewhat indeterminate. Since the end action is so indefinite, many designers consider it dangerous to use C less than 1. When a column with one end fixed and one end free is considered, $C = 2$, indicating a critical load 1/4 as large as the fundamental case. This case, of course, cannot be neglected.

Equation 2 has proved to be reasonably correct for long columns. Furthermore, the simple stress equations have been shown to be quite satisfactory for direct compression in short members. It is necessary to span this gap with an equation of a smooth curve which is tangent to the Euler curve for large values of length L, and which is equal to the compressive strength of the material for smaller lengths.

Intermediate Length Columns: Johnson's parabolic formula fits the transition requirements, and numerous tests have substantiated the validity of the relationship. The parabolic equation may be written in the form

$$s_c = \frac{F_c}{A} = s_y - \frac{s_y^2 (CL/k)^2}{4\pi^2 E} \qquad (3)$$

where the yield stress, s_y, is assumed to be close enough to the proportional limit for Hooke's law to apply.

Consider the case of a specific material whose yield stress s_y is 36,000 psi. For this material Equations 2 and 3 are graphically depicted in Fig. 2 for a pivoted-end column. Note the intersection of Johnson's curve with the Y axis at a point corresponding to the compressive yield stress of the material. From $L/k = 0$ to $L/k \approx 30$, Johnson's curve is essentially horizontal, indicating

$$s_y = \frac{F_c}{A} \approx s_c \qquad (4)$$

which is the simple case of direct compression for a short member. From $L/k \approx 30$ to $L/k \approx 130$, Johnson's curve has been experimentally verified, and may be used for this range. When $L/k > 130$, where failure occurs due to lateral deflection only, test results show that Euler's curve may be applied.

Thus a specific value of L/k exists for any given material which marks the point of tangency, to the left of which Johnson's formula applies and to the right of which Euler's formula is used.

Consider the case of another material with yield stress of 60,000 psi. Equations 2 and 3 are also depicted graphically for this material (Fig. 2) when it is used in a pivoted-end column. Again, Johnson's curve is essentially horizontal for low values of L/k, and the point of tangency occurs at $L/k \approx 100$. This point may be found by

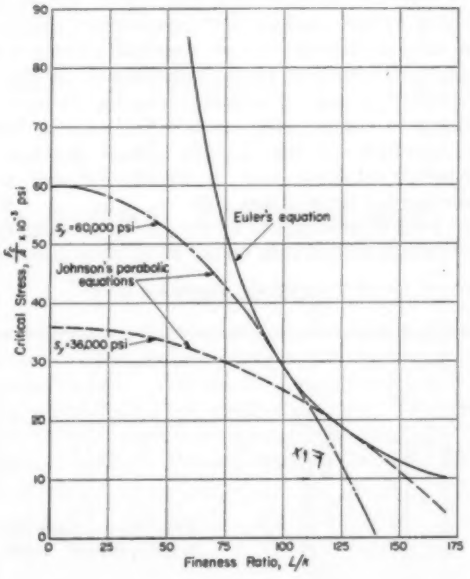

Fig. 2 — Point of tangency between Euler and Johnson equations.

equating Euler's equation to Johnson's formula as follows:

$$\frac{F_c}{A} = \frac{\pi^2 E}{(CL/k)^2} = s_y - \frac{s_y^2 (CL/k)^2}{4\pi^2 E} \qquad (5)$$

which, when solved for L/k, becomes

$$L/k = \frac{4.44}{C}\sqrt{\frac{E}{s_y}} \qquad (6)$$

Equation 6 may then be used to determine the point of tangency for any material for which s_y and E are known, providing that the column conditions fall within the assumptions previously noted.

A log-log plot of Equation 6 is shown in Fig. 3 with the modulus of elasticity E and the end-fixity constant C as parameters. Plotted on the abscissa are values of L/k for $C = 1$ (pivoted ends), and $C = 2$ (one end fixed, and one end free). It is noted from Equation 6 and Fig. 3 that, for any constant E, the higher the compressive strength of the material, the lower the resulting L/k point of tangency.

Johnson's formula is, of course, only one of many relationships which may be used for intermediate values of L/k. The Rankine-Gordon formula, or any of the many variations of empirical straight-line formulas, can also be made to apply merely by proper selection of constants. Therefore, if it is desired to use any of these other relationships, rather than Johnson's formula, a working chart giving points of tangency may be found in a similar manner.

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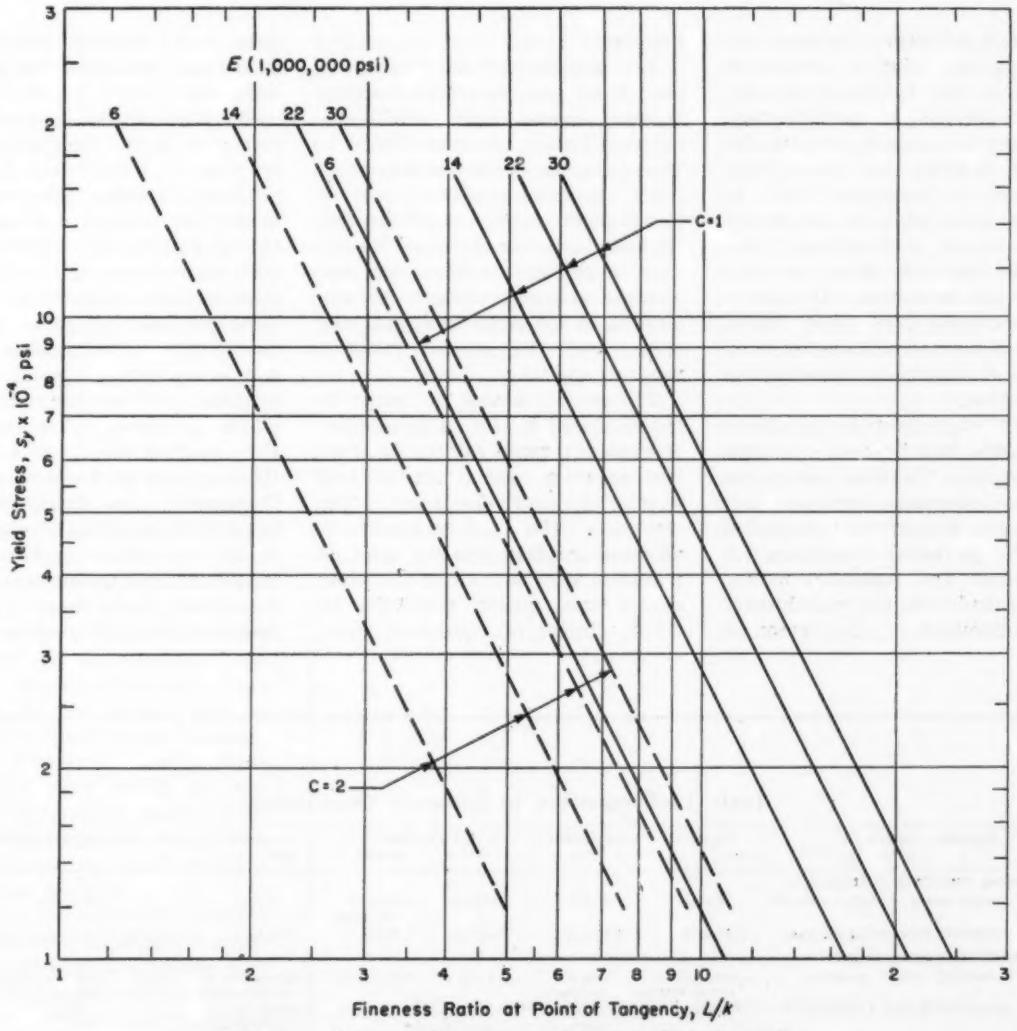

Fig. 3 — Curves of tangency between Euler's and Johnson's equations for range of modulus of elasticity.

Comparing

Analog and Digital Computers

for solving design problems

MAJOR differences between analog and digital computers stem from their fundamentally different approach to mathematics. The digital approach permits the use of nothing but elementary arithmetic operations and "yes" or "no" decisions, while the analog approach is one of functional relationships between dependent and independent variables. Any application of computers which varies from this premise does so by making use of additional mathematical formulation.

Where it is possible to obtain comparable data by analog or digital computer, the final choice depends on necessary accuracy, set-up and calculation times associated with the particular computers, total amount and repetitive nature of the calculation, and past history and preferences of the personnel involved.

The general-purpose computers used today may be placed roughly in four classes having different computational properties, Table 1. These are the electric analog computer composed mostly of passive elements, the electronic differential analyzer using operational amplifiers to perform mathematical operations on analog voltages, the externally-stored program digital machine, and the internally-stored program digital machine.

The electric analog computer is characterized by its large number of elements, rapid calculation, limited accuracy, and a set-up time which is relatively short. The electronic differential analyzer usually has smaller capacity, greater potential accuracy, about the same set-up time, greater flexibility in the treatment of non-linear functions, and somewhat longer calculation time than the electric analog computer.

The two digital classes differ primarily in the flexibility of the program, with the internally-stored program machine being able to modify its own program as the result of calculation. More through the chronology of development than inherent properties, the externally-stored program machine usually has limited number storage and is a slow or medium-speed machine, while the internally-stored program machines range from medium speed and storage to the most powerful computers built. Compared to the analog machines, some characteristics of digital machines are more set-up time for the initial calculation but less for any subsequent ones from the same program, accuracy limited only by

Table 1—Comparison of Computer Characteristics

Type of Computer	Capacity	Calculation Time	Set-Up Time		Accuracy (per cent)	Treatment of Nonlinearities
			Initial	Repeat		
Analog (functional relationships)						
Electric analog (passive element)	Large	Short	Medium	Short to medium	1 to 5	Difficult
Electronic differential analyzer	Medium	Medium	Medium	Short	0.1 to 5	Easier than electric analog
Digital (elementary arithmetic)						
Externally stored program	Limited by internal storage	Long to medium	Long	Very short	Limited only by math involved	Easy if analytic, difficult if arbitrary
Internally stored program	Unlimited	Medium to short	Very long	Very short	Limited only by math involved	Easy

DESIGN ABSTRACTS

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the mathematics involved, simpler handling of arbitrary functions, more awkward formulation of differential equations, and extremely rapid arithmetic.

Problem Characteristics: The characteristics of computers discussed briefly in the foregoing can take on their proper perspective only when considered with respect to a particular type of problem. Without attempting to fit every problem that the engineer encounters into a neat little slot, a few general types can be established.

One large class of calculations involves straight data conversion by numerical operations according to fixed rules or formulas. This type of computation is almost certainly done more economically by digital computer, the type being determined by magnitude of the problem. At the other end of the spectrum is the large class of problems arising from the transient behavior of control systems. These are handled most easily by the electronic differential analyzer because of the direct representation of time-differential equations possible on this computer.

Transient behavior of systems involving partial differential equations such as electrical power systems or mechanical structures is best studied on the electric analog computer because of its large number of elements and the ease of handling the mathematics. This problem could be solved by differential analyzer, but the size of the system would be drastically limited by the size of the computer since approximately one amplifier would be needed for each passive element of the other representation. This problem could also be solved by digital means but only on the most powerful computer and at the expense of much time and effort, since the formulation for numerical solution is extremely lengthy and requires much calculation time compared to the analog techniques.

Less well defined is the class of static boundary-value problems. The electric analog computer is just as applicable to these as to the transient cases, but now the digital solution appears in a much more favorable light. The decision for analog or digital computation must be based on more information. If the problem is not expected to occur again later and, especially, if a number of variations are to be calculated at the same time, the short set-up and calculation times of the electric analog make it preferable; but if the problem is expected to recur frequently with only a few cases each time, the short set-up time of the digital solution after the initial program has once been written would probably compensate for the longer calculation time. The digital solution may be justifiable initially on the basis of increased accuracy beyond the 1 or 2 per cent of the analog, but the digital solu-

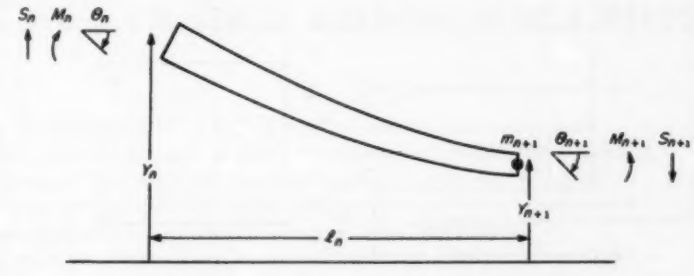

Fig. 1—Beam section and factors involved in typical problem.

tion also is only as accurate as the representation.

Another class of calculations which may include elements of the above types and where each case must be examined individually is optimization of design. Depending on the type of calculations performed in the optimization, the decision may be clear-cut, but where either computer is applicable, the ease of parameter variation in the analog must be weighed against the automatic decision-making features of the digital computer. The frequency with which the problem is encountered is likely to be the deciding factor.

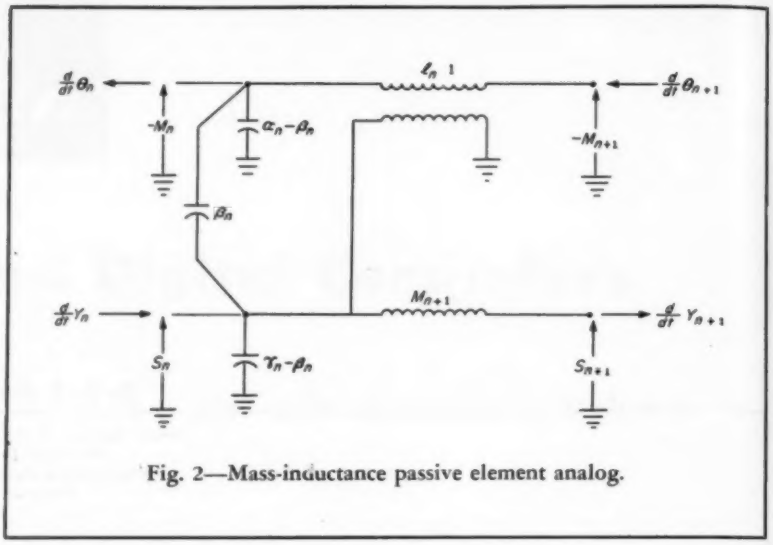

Fig. 2—Mass-inductance passive element analog.

Typical Problems: The following examples illustrate typical uses of automatic calculation:

1. TRANSIENT BEHAVIOR OF MECHANICAL SYSTEMS COMPOSED OF COUPLED BEAMS: Many mechanical structures of interest to the engineer fall into the general class of coupled beams. Once a preliminary design for a structure has been arrived at, one or more different types of analysis may be necessary to prove the design. Probably the most difficult data even to estimate by hand methods are the stresses and deflections experienced under the influence of some transient shock.

One approach to simplification of the mathematics is to reduce the partial differential equations to a set of ordinary differential equations by considering the finite difference equations at points along the lengths of the beams. If the mass is considered lumped at discrete points, equations relating the physical quantities at the ends of a section as shown in Fig. 1 may be written as follows:

$$S_{n+1} = S_n - m_{n+1}\frac{d^2}{dt}Y_{n+1} \quad (1)$$

$$M_{n+1} = M_n + l_n S_n \quad (2)$$

$$\theta_{n+1} = \theta_n - \alpha_n M_n - \beta_n S_n \quad (3)$$

$$Y_{n+1} = Y_n - l_n \theta_{n+1} - \beta_n M_n - \gamma_n S_n \quad (4)$$

where α_n, β_n and γ_n are elastic coefficients and S, M, θ and Y are shear, moment, angle and displacement, respectively.

A digital transient solution to the system made up of a number of sets of these equations is admittedly possible, and other approaches may yield an easier digital solution. However, the preparation of a program having sufficient flexibility to handle general problems of this type would be an enormous task.

A number of relatively simple analogs representing Equations 1 through 4 are obtainable. Two of these are shown in Figs. 2 and 3. Fig. 2 is a mass-inductance passive element analog, while Fig. 3 is an electronic differential analyzer analog.

These analogs are relatively easy to set up and interconnect to satisfy boundary conditions of complex structures. Though the total number of sections represented is limited by the amount of equipment available and by the accuracy of the elements, the choice of analog

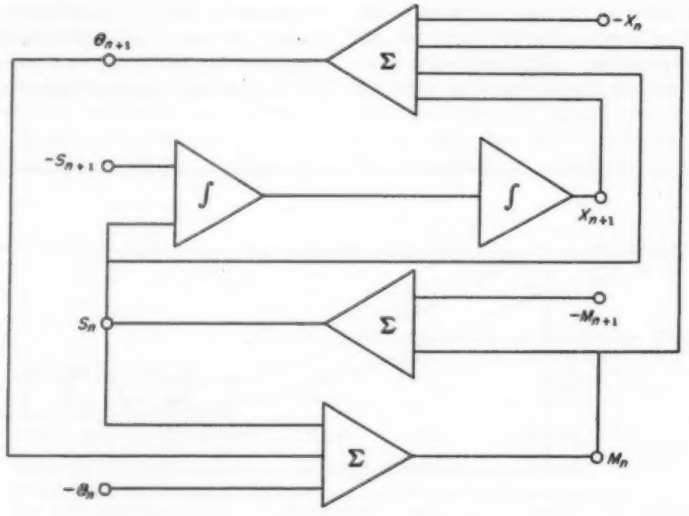

Fig. 3—Electronic differential analyzer analog.

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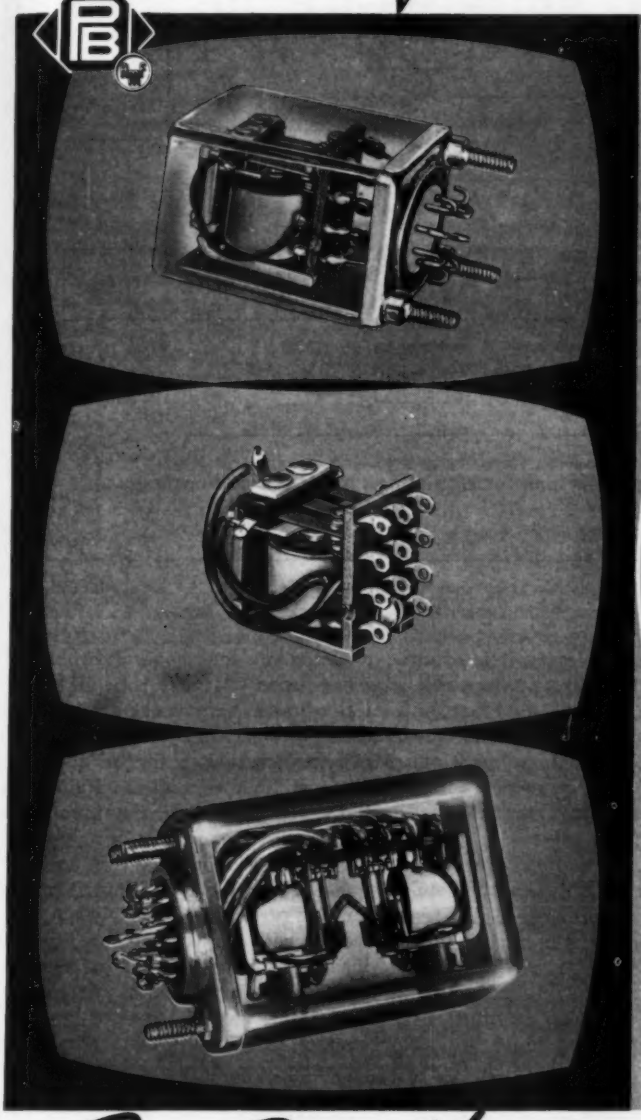

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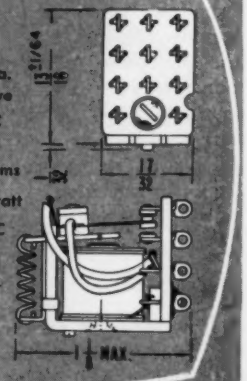
PULL-IN: 75% of nominal voltage
TERMINALS: Solder lugs



Designated as the KE, this latching relay combines two KMs for minimum size and weight. It operates on momentary impulse to either coil with a mechanical latch and electric release. Available up to 6 PDT. This relay was designed for intermittent duty only. Three-stud mounted with solder terminals. Hermetically sealed model is shown at left. Also available in open version.

Good Relay News! KM SERIES ANSWERS DESIGN NEEDS

Designers plagued with problems of miniaturization welcome the KM series as good relay news. These subminiature relays—open, hermetically sealed and latching—are wonderfully versatile, light in weight, and amazingly compact. The open KM occupies less than a cubic inch of space! Application possibilities range over such diverse fields as remote control systems, automated toys, small business machines and alarm systems. New applications suggest themselves daily to engineers working with designs where component size and weight must be kept to barest minimums. Your inquiries about our KM series relays are invited!

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equipment over digital computer is clearly indicated by the ease of handling the mathematics and the associated shorter set-up time.

2. NATURAL FREQUENCIES OF COUPLED BEAMS—CRITICAL SPEEDS: In a large number of mechanical problems, only the natural frequencies and the stresses associated with them are of primary interest. One such case is the design of turbine-generator rotors where the natural frequencies must not coincide with the running speed or its harmonics.

The frequencies may be obtained from the same analogs used for transient work, but in this case the prospects for digital calculation are much brighter. Since the motion of any point in the structure will be sinusoidal with time when a single natural frequency is excited, Equation 1 may be rewritten as:

$$S_{n,1} = S_n + m_{n,1}\,\omega^2\,Y_{n,1} \qquad (5)$$

Now Equations 2 through 5 may be employed in a calculation to obtain the desired frequencies. Comparing the essentially constant set-up time, limited capacity and limited accuracy of the analog solution with the short set-up time after the initial programming, unlimited capacity, high accuracy and smaller chance for error of the digital solution, the choice of digital solution is well defined. The one possible exception to this is a situation where a large number of relatively minor variations are to be examined at one time. In this case, the short solution time may make the passive analog method the more attractive.

3. REGULATING SYSTEMS: The regulation of the voltage of a turbine generator is a representative example of a complex feedback control system. Fig. 4 is a block diagram of the regulating system and is presented to illustrate the complexity of the problem.

The straightforward approach to most regulating systems is provided by the electronic differential analyzer. This problem is no exception in that the differential analyzer will provide the most data on the transient response with the least effort. However, with systems of this complexity it is often difficult to foresee the best approach to system modification when the analog indicates an unacceptable solution. Some additional information, or some better evaluation of the same information, is often desirable.

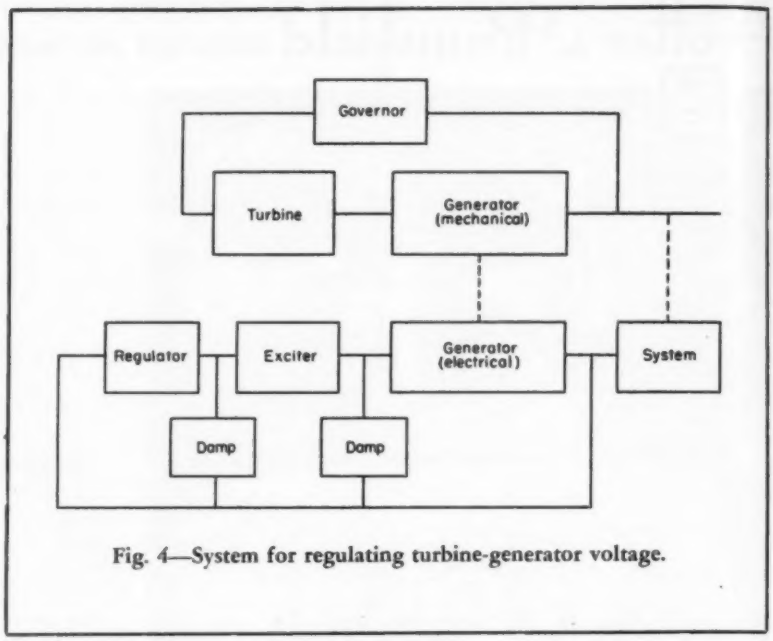

Fig. 4—System for regulating turbine-generator voltage.

A digital approach to transient response based strictly on the solution of the differential equations would not yield anything new and in addition would be more difficult than the analog solution. However, the information supplied by phase-gain analysis, while it does not yield accurate transient data, is quite useful for qualitative prediction. A digital computer is admirably suited to the computation of this type of data, whereas phase measurements from an analog are not altogether satisfactory.

Thus, there are some problems where analog and digital machines can work together profitably.

Conclusions: Providing an analog can be devised, transient problems involving partial differential equations are best handled on a passive element electric analog computer. The electronic differential analyzer is less satisfactory because of capacity limitations but offers some compensation in handling nonlinearities.

Transient and control problems based upon ordinary time-differential equations are most easily handled by electronic differential analyzer. However, a digital solution is feasible and may be indicated by a repetitive problem involving highly nonlinear functions.

Most static boundary-value and quasi-steady-state oscillatory problems may be solved nearly equally well by either analog or digital means. Low frequency of occurrence and many minor parameter variations indicate use of analog equipment. Repetitive set-up and extreme accuracy and capacity requirements indicate use of digital computer.

Data-reduction problems and economic optimization based on a choice of functionally similar designs are best handled digitally.

A large number of calculations, primarily performance calculations, may be approached by different paths on analog and digital computers. The use of both approaches to obtain complementing data is often worthwhile.

From a paper entitled "Analog Versus Digital Techniques for Engineering Design Problems" presented at the Fifth Annual Industrial Electronics Symposium sponsored by IRE and AIEE, in Cleveland, September, 1956.

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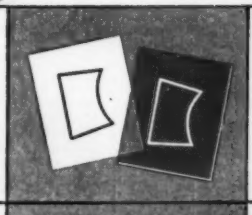

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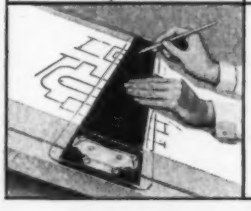

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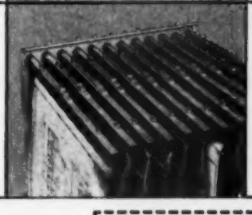

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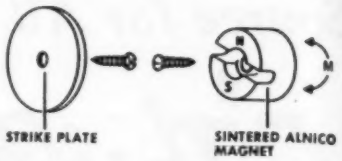
A survey of

Magnetic Latches

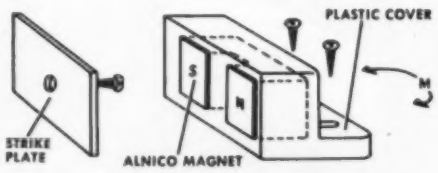
By Richard A. Scholten

Design and Application Engineer
Indiana Steel Products Co.
Valparaiso, Ind.

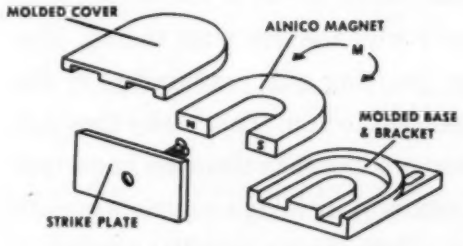
PERMANENT-MAGNET latches offer unique application possibilities. Pictured here are some of the more popular types with descriptions of their design features. *From "A Survey of Magnetic*



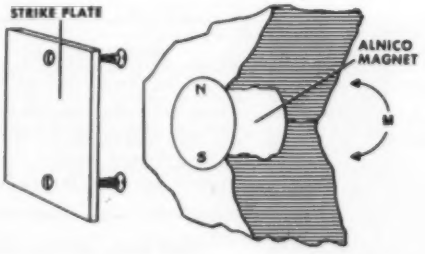
1. Small Sintered Alnico II magnets of the round two-pole type which provide simple, inexpensive latches where magnetic strength is not too important. May be mounted by tacks, screws or glued in drilled holes in nonmagnetic material.



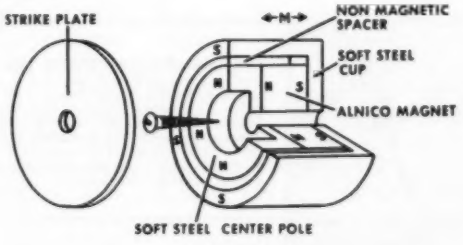
2. Latch consisting of a simple U-shaped Alnico magnet inserted in a molded plastic or die cast cover. Covers a wide range of magnetic strength and provides good performance under gap conditions.



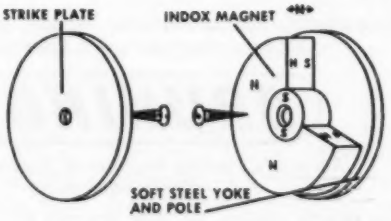
3. Similar to Fig. 2, except magnet is held loosely in assembly, thereby simplifying alignment with strike plate.



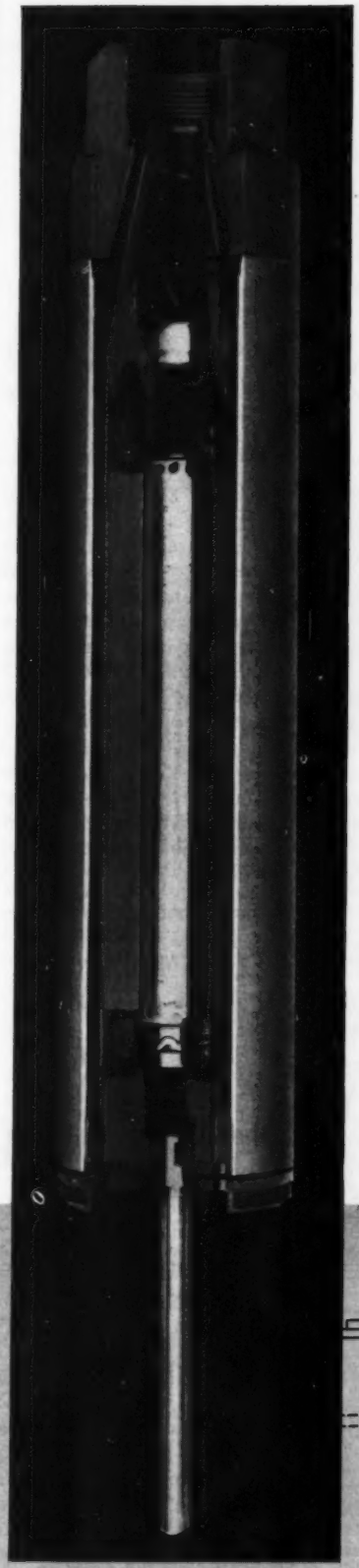
4. Round flat-faced magnet magnetized with two poles on the contact face. Usually Alnico V or Alnico VI, with preferred magnetic axis perpendicular to contact face. Has moderate strength but is simple and neat in appearance for deluxe cabinet applications.



5. Cup-type Alnico assembly giving very great strength at direct contact for minimum space and material usage. Generally expensive.



6. Ring-type assembly using Indox I magnet. Soft-steel center pole provides high flux density for greatest pull.



7 "bonus values" of Leland's submersible motor!

Now both motor and pump can be installed right in your gasoline storage tank! Even with high octane gasolines, the new Leland explosion-proof motor eliminates vapor-lock . . . uses the gasoline itself for lubrication and cooling. This completely new ¾ hp, 230v AC thermally protected motor measures only 3½ inches in diameter . . . fits into existing tanks. It's fully U.L. Approved for Class I, Group D service.

Simple and rugged, built for long-life economy, this new Leland submersible pump motor has these 7 big advantages over other motors:

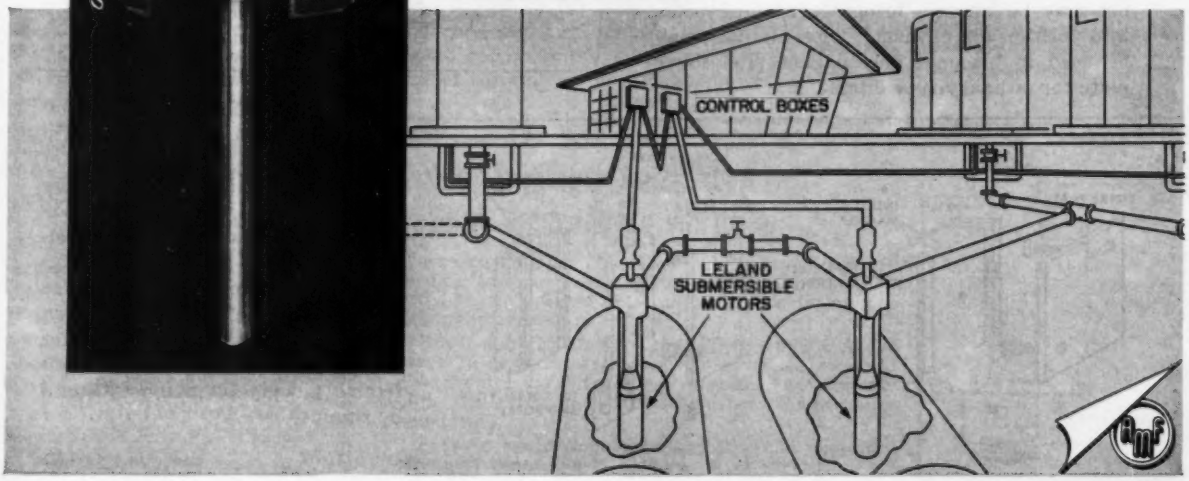
1. Completely self-contained unit includes outer shell necessary for gasoline passage – makes expensive extras unnecessary.
2. Extruded aluminum outer shell becomes main structural member – ribbed design provides much needed rigidity.
3. 9/16" chrome-steel shaft extension provides greater strength–prevents mechanical distortion.
4. Increased annular area allows 10% greater gasoline flow–minimizes trouble-making back pressure and turbulence.
5. Suction stub mounts without adaptor castings – reduces expense required with other motors.
6. Plastic-impregnated windings surpass wet-design insulation requirements – remain trouble-free for extra-long service life.
7. Leland's integrated motor design permits complete removal of pump or stub *without* disassembling motor.

In addition . . . a remote-control box is supplied with each Leland submersible pump motor. Includes thermal overload protector, line control and starting relays, starting and running capacitors.

30 years ago Leland developed the first gasoline curb pump motor to receive U.L. Approval – today, Leland gasoline pump motors outsell all others combined. So there's good reason why, for explosion-proof motors of any kind, your best bet is Leland. If you would like more information, and/or a copy of a new brochure on the submersible motor, write, wire or phone us –TODAY!

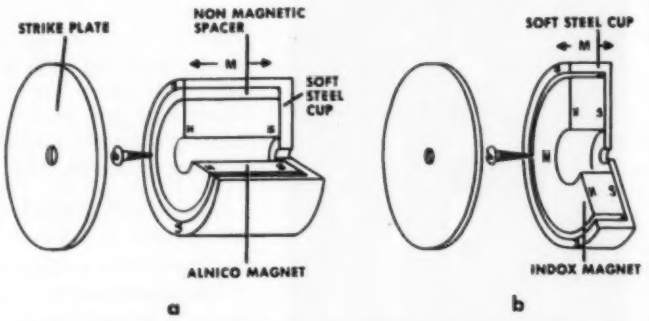
Another AMF Product
LELAND MOTORS

THE LELAND ELECTRIC COMPANY
Dayton 1, Ohio
Division of AMERICAN MACHINE & FOUNDRY COMPANY



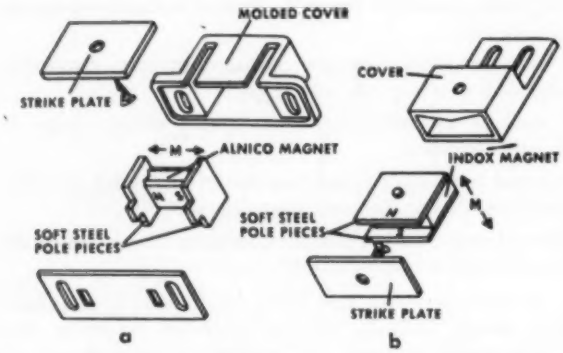
Circle 578 on page 19

Latches" in Applied Magnetics, *Published by Indiana Steel Products Co., October-December,* 1956.



7a. Simplified Alnico cup-type assembly, with slug-type magnet held inside a steel cup. Is more effective than same magnet in Fig. 5, however, less effective at small gaps. Magnet may be mounted with screw in center or pressed into hole.

7b. Indox cup assembly, with Indox magnet glued in steel cup. Has good direct contact and gap pull.

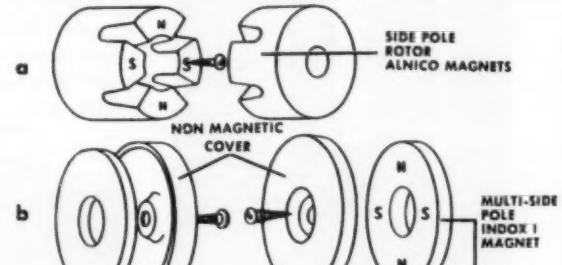


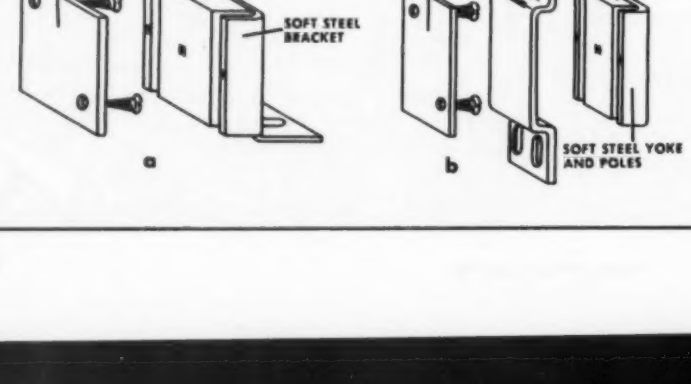
8a. Practical assembly where quantities warrant proper tooling. Magnetic circuit design using soft steel poles spaced by single Alnico bar magnet provides maximum contact pull for minimum of permanent magnet material. Is less effective through gaps. This basic magnetic circuit, in combination with a great variety of mechanical assembly designs in which parts are mounted loosely for self aligning feature, is very popular for mass, cabinet-latch market.

8b. Simple modification of Fig. 8*a* to use Indox I permanent magnet. High coercive force permits flat "sandwich" type circuit in a variety of mechanical retainers. Design becoming very popular.

9a. Cast Alnico magnets of side-pole rotor type which provide great strength both at direct contact and at gaps. Rotation of one magnet brings repelling poles into position for simple releasing. Steel washer may be used in place of one magnet for ordinary type latch.

9b. Indox I ring magnets magnetized with poles on face, using nonmagnetic cover to protect Indox from breakage and to provide for mounting. Has low pull at small gaps but is very efficient for large gaps. One magnet may be rotated, bringing repelling poles into position for releasing. Steel washer may be used in place of one magnet plus cover plate for ordinary type latch.





10a. Simple Indox I assembly. Has less contact pull than that in Fig. 8*b*.

10b. Simple Indox I assembly with mounting method to provide self aligning and different positioning. Large pole-face on magnet gives low-reluctance path for flux through the retainer; however, less pull will be produced than for assembly in Fig. 10*a* due to effective air-gap on magnet caused by retainer.

RB&W FASTENER BRIEFS

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Technical-ities

By John S. Davey

Bolts take greatest stress during wrenching

If a bolt doesn't fail when being wrenched up tight, it won't fail in service (assuming bolts and joint have been designed adequately for the loads).

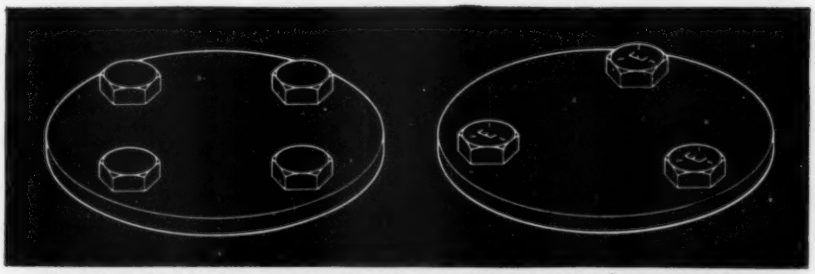
That's because two forces put stress on bolts (and cap screws) as they tighten: Tension due to bolt stretch; torsion due to friction. But only tension remains after wrenching. In a rigid joint, if this tension exceeds external forces, bolts will never experience any further strain, and will therefore not loosen or fail.

WHY SOME FAILURES?

Obviously, unusual unforeseen loads cause trouble. The instant they exceed residual tension, *they add* to the stress placed on the bolt and can cause *immediate* failure. Or they can cause loosening, leading to stress change, which in turn causes fatigue and failure. That's why you've got to torque bolts tight . . . and the tighter the better.

An exception: A flexible joint. With high cyclic loading, again loosening and fatigue cause trouble. Since you shouldn't tighten such a joint too much, sometimes the only remedy is to take out the flexible element and put in a rigid joint. (A metal to metal flange connection instead of a gasketed one, for example.)

Are you using more bolts than needed?



The stability of a 4 bolt arrangement can be matched by a 120° spacing of 3 bolts. Strength can be actually increased by using RB&W high carbon heat treated bolts (identified by "E" and three radial dashes).

NOBODY wants to use too few bolts or cap screws and risk failures. But using too many is not the best answer either. It means too many holes to drill, to fill — both costly.

RB&W offers some suggestions.

BALANCED BOLT PATTERN

By "rule of thumb," bolts are generally arranged symmetrically in a pattern of four. Yet three bolts 120° apart around a common center will prove just as stable, and save on assembly. With stability assured, the problem is then one of load capacity.

PRELOAD TO GET FULL CAPACITY

In checking size and number of bolts, calculate the stress and get rid of the excess. You have enough if you've allowed for usual factor of safety . . . *and the fasteners are tightened so that residual tension exceeds maximum external load anticipated.* If they are, you have safety. The bolts will *stay* tight, won't fatigue, won't fail.

With RB&W standard fasteners, engineers and production men can take quality, uniformity and dependability for granted — and can concentrate on the problem of proper application and assembly. For help or information on your specific product, write Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N.Y.

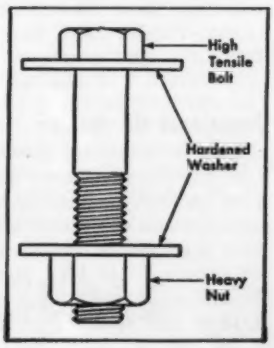
Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

High strength bolts stop joint failure from vibration

Shakeout equipment used by one company for unloading coal cars applied its vibration via a fabricated frame lowered onto the cars. This frame was originally riveted.

But it was a constant source of maintenance. About every 10 days, the frame had to be welded, loosened rivets replaced. Finally it was refastened with RB&W high tensile bolts and hardened washers. Maintenance now is *nil!*

Proving again that high strength bolts make the strongest connection for the severest service.



Circle 579 on page 19

HELPFUL LITERATURE

for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Electronic Equipment

Control system analyzers and synthesis equipment, servo amplifiers, electromechanical assembly kits, signal generators, pyrometers, heat detector cells, photometers, direction finders and communications receivers are some of the electronic systems, equipment and components detailed in short form catalog SF-9901. 16 pages. Servo Corp. of America.

Circle 401 on page 19

Small-Lot Stampings

Techniques employed in economically producing stampings in small lots to customers' requirements are related in illustrated bulletin 151. In addition to explaining precision piercing and blanking methods, suggested basic designs for metal stampings are shown. 24 pages. Dayton Rogers Mfg. Co.

Circle 402 on page 19

Corrosion Resistant Materials

Brief descriptions of Tygon flexible plastic tubing, gasketing, protective coatings, tank linings, corrosion resistant masonry and chemical ceramics are given in illustrated bulletin S-1 1801. Also covered are fabricated towers of various types and tower packing. 8 pages. U. S. Stoneware Co.

Circle 403 on page 19

Heat Transfer Units

Data on how to cut heat transfer costs in a wide range of industrial applications are among contents of illustrated bulletin IP-356. Construction details are shown, and ten advantages of Platecoil units are listed. Sketches show 14 actual installations. Tranter Mfg., Inc. Platecoil Div.

Circle 404 on page 19

Fractional HP Motors

Line of fractional horsepower direct current permanent magnet motors, as well as gearheads, centrifugal blowers and tachometer generators, is subject of condensed illustrated catalog F 4344-3. Motors are 6 to 115 v dc units with outputs to 1/10-hp and speeds from 5000-20,000 rpm. 4 pages. Barber-Colman Co., Aircraft Controls Div.

Circle 405 on page 19

Fabricated Steel Tubing

Advantages of having steel tubing partly fabricated to your designs are described in illustrated folder PO 2256. Zincgrip (tightly zinc coated) and Aluminized (aluminum coated) special types are available. Sections on machining operations are included. 4 pages. Armco Steel Corp.

Circle 406 on page 19

Retractile Cords

Wide range of applications for line of retractile cords in industry and other fields is found in illustrated catalog 556. The springlike cords extend to about six times their retracted length. Specifications for standard types are given. 12 pages. Koiled Kords, Inc.

Circle 407 on page 19

Variable Speed Motor Pulley

Improvements made in the No. 800 Vari-Speed Jr. motor pulley are outlined in illustrated bulletin V-563. Five sizes range from ⅛ to 1½-hp capacity, with ratios up to 2.75:1 and speeds from 135 to 1965 rpm. Design details are shown. 8 pages. Reeves Pulley Co.

Circle 408 on page 19

Electronics Alloys

"Pennrold Precision Strip for Electronics Applications" presents case history and other data on thin-gage beryllium copper, phosphor bronze, nickel silver, chromium copper, stainless 17-7 PH, Invar and magnetic strip down to 0.0005-in. thick. 8 pages. Penn Precision Products, Inc.

Circle 409 on page 19

Nylon Pressure Tubing

Properties and applications of Nylaflow nylon pressure tubing are detailed in illustrated bulletin "A Case History of Engineering Progress." 8 pages. Series of 2-page case histories and technical bulletins cover specific applications and properties. Polymer Corp. of Pennsylvania.

Circle 410 on page 19

Production Facilities

Examples of products that can be produced by this company are shown in bulletin. Included are large crankshafts, aircraft forgings, machinery assembly, hydraulic press rods, ordnance parts, cylinder blocks, boat shafting, press cylinders and flame hardened rolls. 4 pages. National Forge & Ordnance Co.

Circle 411 on page 19

Two-Way Valves

Two-way directional control valves for fluid power systems up to 3000 psi are described and illustrated in bulletin 80200. Construction details are given. Wide choice of plungers and flanges is offered in five styles of operators. 16 pages. Oilgear Co.

Circle 412 on page 19

Heat Treating Beryllium Copper

Methods and procedures used to heat treat beryllium copper wrought and casting alloys are described in catalog. Tables of physical and engineering properties are included. 8 pages. Beryllium Corp.

Circle 413 on page 19

Vibration Pickups

Bulletin 124E on MB velocity-type pickups includes data on design and method of operation, specifications and typical frequency-response curves for damped and undamped types. Model M-1 and M-3 vibration meters are also covered. 6 pages. MB Mfg. Co.

Circle 414 on page 19

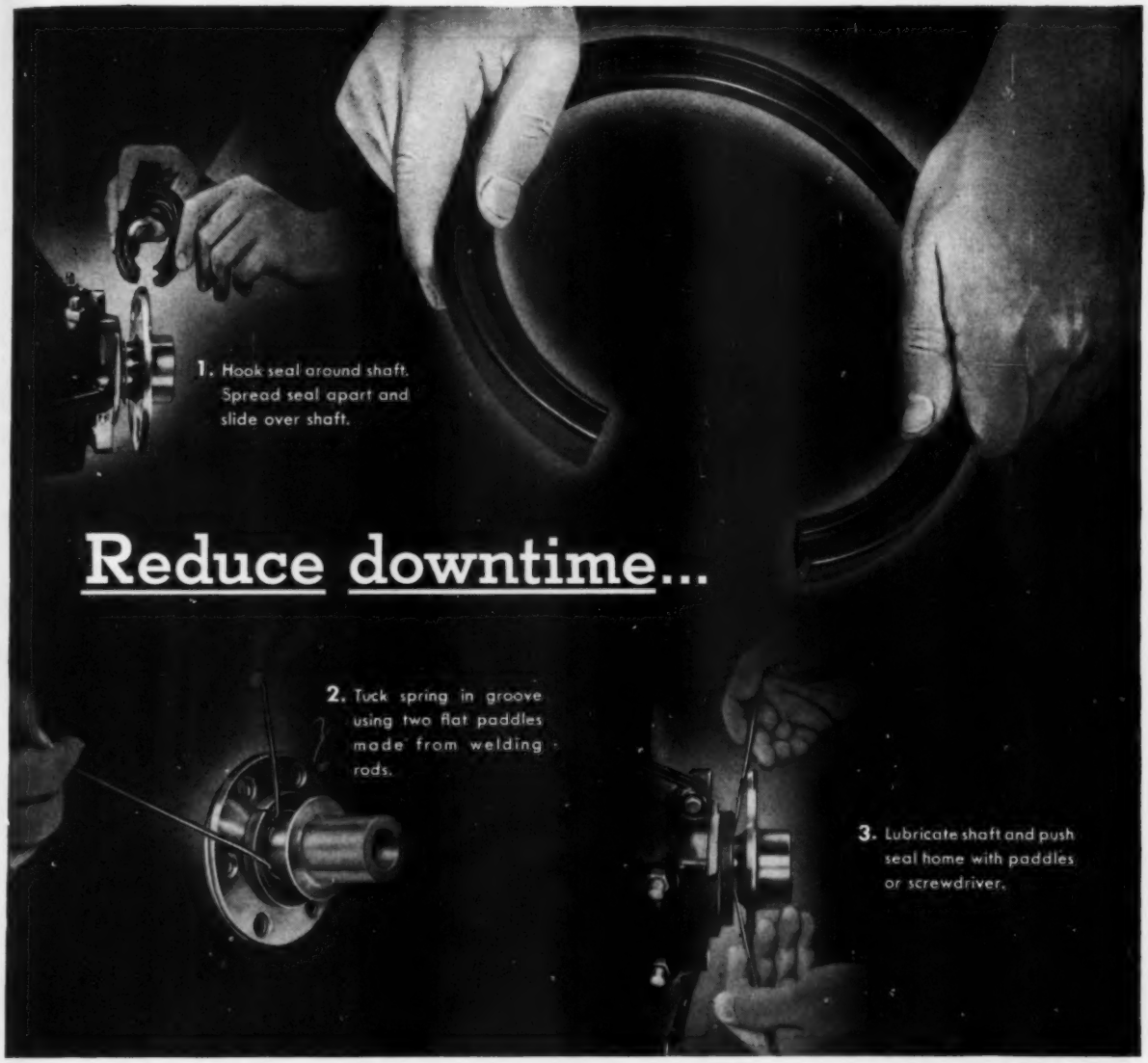
Tracing Papers

Samples of three tracing papers and price list are provided in file folder. Included are a fast tracing vellum for all process reproductions; a rag natural bond tracing stock; and an economical tracing paper with fast speed. Latmer Sales Co.

Circle 415 on page 19

Insulation Material

In addition to thermal and acoustical performance, form WML-5 briefly describes how Microlite insulation is made and what it is made


1. Hook seal around shaft. Spread seal apart and slide over shaft.
Reduce downtime...
2. Tuck spring in groove using two flat paddles made from welding rods.
3. Lubricate shaft and push seal home with paddles or screwdriver.

How J-M Split Clipper Seals speed installation

... flexible body provides easy installation and removal even with small clearances

"Downtime" is measured in seconds when Clipper Seals do your sealing. Furnished in split form and made from a highly flexible synthetic rubber compound, they can be readily slipped into the tightest spots. Neither special training nor special tools are required . . . no drilling and tapping for cover plates is necessary because cover plates are not needed.

Clipper Seals are virtually fracture-proof and stand up well under rough handling by inexperienced mechanics. The self-adjusting garter spring has a hook and eye which is easily hooked around the shaft. It is then a simple procedure to slip it into the groove. When the shaft end is accessible, solid seals are used and snap into place almost as quickly as you can say "Clipper Seal." What's more, they stay put.

Reduced "downtime" is only one of many advantages you get with J-M Clipper Seals. Precision moulded from a variety of corrosion-resistant compounds specially developed for each service, they provide maximum sealing ability, low torque, long life and wide adaptability. For more information on the complete line of Clipper Seals, write for new 28-page illustrated brochure PK-71A. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

JM PRODUCTS **Johns-Manville CLIPPER SEALS**

Circle 580 on page 19

of. Uses in heating and air conditioning systems, appliances and in industry are pointed out. 4 pages. L.O.F. Glass Fibers Co.

Circle 416 on page 19

Adjustable Speed Drive

Control station, adjustable-speed drive motor and the control unit comprise the Xatron V-S drive described in folder D-2351. Drive utilizes an Xatron tube to rectify incoming ac to provide source of adjustable dc power to drive motor. 4 pages. Reliance Electric & Engineering Co.

Circle 417 on page 19

Plastic Products

In addition to information on chemical, electrical and mechanical properties of Teflon and Raylon, brochure 6905 also provides specification on various sizes in which sheets, tape, molded and extruded rods and tubes in these plastics are available. 8 pages. Raybestos-Manhattan, Inc., Plastic Products Div.

Circle 418 on page 19

Thermocouple Accessories

Adapters, resistors, terminals, as well as firewall, bayonet and quick-disconnect connectors are among thermocouple accessories described in bulletin 1610-A. Cross reference of products arranged by AN equivalents is included. 4 pages. Revere Corp. of America.

Circle 419 on page 19

Round & Square Tubing

Tolerances and additional size ranges for square, rectangular and round carbon and stainless steel welded Electrunite tubing are provided in reference data available in wall, desk and pocket type charts. Physical properties are set forth as welded normalized, drawn and mandrel drawn. Republic Steel Corp., Steel and Tubes Div.

Circle 420 on page 19

Fractional HP Motor

Included in brochure on the AL-4 fractional horsepower MicroMotor are features and applications, plus an illustration of Tri-Flux design which increases starting and running torque. Six models range from 1/75 to 1/15 hp. 4 pages. Redmond Co.

Circle 421 on page 19

Diaphragm Valves

Catalog No. 100 on diaphragm valves covers their advantages, applications and specifications. Handwheel, lever and air-operated valves are shown. Valves handle corrosive or hazardous fluids and slurries at temperatures up to 350° F and pressures to 150 psi. 12 pages. Hills-McCanna Co.

Circle 422 on page 19

Vibration Mountings

Engineering and design data, plus a guide to selection are provided in bulletin 702 on "Plate Form and Multiplane Mountings." Used to isolate vibration and shock, mountings are made in ½ to 310-lb capacities. 16 pages. Lord Mfg. Co.

Circle 423 on page 19

Circuit Breakers

Revised bulletin 3411 details the hydraulic-magnetic principle, design, operation and application of general-purpose circuit breakers. Single, two and three-pole breakers are specified. All units will hold 100 per cent rated load. 20 pages. Heinemann Electric Co.

Circle 434 on page 19

Electrical Wiring Devices

Indexed catalog covers expanded line of electrical wiring devices. Shown are fluorescent and incandescent items, cover sockets, industrial terminal blocks and specialties for navy, maritime and aircraft uses. 32 pages. Kulka Electric Mfg. Co.

Circle 425 on page 19

V-Belts

Catalog V-55 describes fractional horsepower, multiple, super strength, steel cable, open end and hexagonal double V-belts for all types of V-drives. Section is also devoted to V-link belting. 24 pages. Maurey Mfg. Corp.

Circle 426 on page 19

Plastic Pipe & Fittings

Information covering technical properties, chemical resistance, sizes, pressures and dimensions, and prices for Ace Riviclor PVC plastic pipe, fittings and valves from ½ to 2 in. is provided in bulletin CE-56. 8 pages. American Hard Rubber Co.

Circle 427 on page 19

Injection Molded Plastics

Injection molding of small nylon and other thermoplastic parts weighing 0.03-oz and only 1¼ in. long, is discussed in bulletin. It covers dimensional and weight limits and illustrates many of the parts that can be molded. 4 pages. Gries Reproducer Corp.

Circle 428 on page 19

Forged Steel Unions

Forged steel unions described in bulletin U-1-56 include 3000-psi types made to AAR specifications; two and four-bolt flange unions in 2000 and 3000-psi classes; 3000-psi O-ring flange unions; as well as orifice, tab orifice, clamp ring, forged stainless steel and lug nut unions. 8 pages. H. K. Porter Co., W-S Fittings Div.

Circle 429 on page 19

Production Brazing

New series of technical articles entitled "Techniques of Metals Joining" published by this company gets under way with illustrated reprint of "Production Brazing" (TIS 2635), a paper delivered to the 1956 meeting of the International Institute of Welding. 9 pages. Eutectic Welding Alloys Corp.

Circle 430 on page 19

Casters

Over 40 new models of casters are described in illustrated catalog 412-A which also lists practical application suggestions and caster selection data. Casters have solid rubber, semipneumatic and full pneumatic wheels in range of capacities. 4 pages. Gleason Corp.

Circle 431 on page 19

Overheat Detectors

Thermistor-actuated overheat detectors for use in aircraft are described in brochure MC-134. Literature discusses advantages of sensing temperature with thermistor elements, suggests applications and installation techniques and lists physical, performance and military specs data. 4 pages. Fenwal Inc.

Circle 432 on page 19

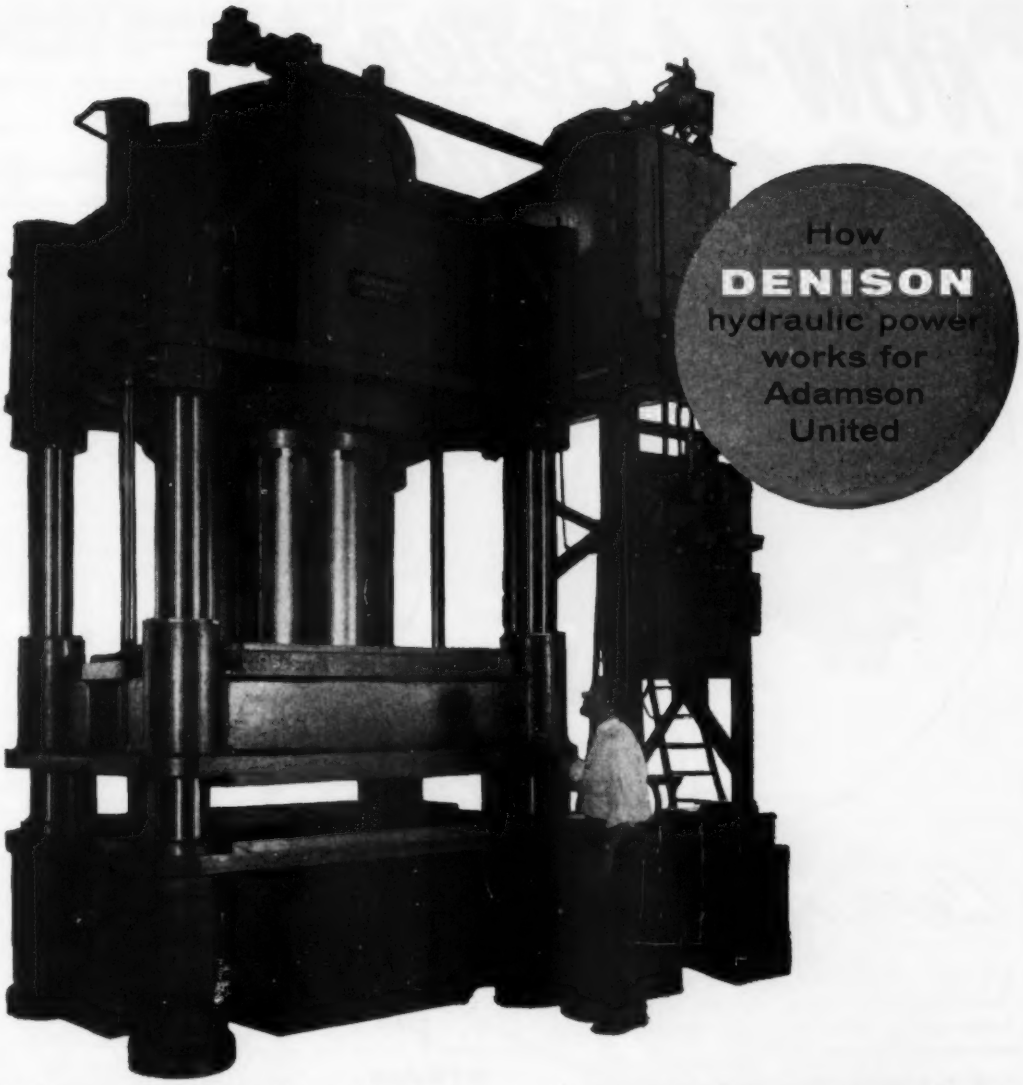
Copying Machines

How diazotype copying machines eliminate up to 90 per cent of the writing in preparing production and assembly orders is told in brochure A-2282. Also explained is the application of mechanical copying in preparation of subassembly and final assembly orders. 8 pages. Charles Bruning Co.

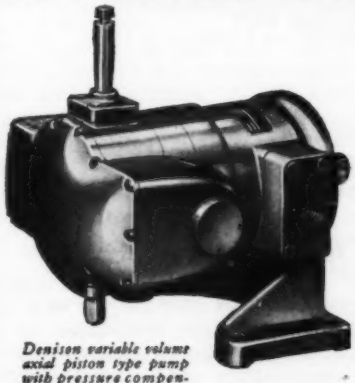
Circle 433 on page 19

Fiber & Plastics

Comparative evaluations of laminated plastic and vulcanized fiber are included in comparator chart. Thirty - four basic grades of fiber and plastics are compared and 23 material property ratings are given



Precision control for a metal monster



Denison variable volume axial piston type pump with pressure compensating control, key to this hydraulic system for Adamson United Press.

● To Denison Engineering went the task of designing accurate, foolproof control equipment for this huge compacting press built by Adamson United, Akron, Ohio. Covering more than 40 square feet of platen area, the press has a 40-inch ram designed to operate on a 2300 psi hydraulic system.

The control system developed by Denison employs a variable-volume axial-piston pump driven by a 15 h.p. motor. A manifold-type hydraulic panel completes the system.

Engineering consulting service like this is available to you at all times to save your design time and assure dependable, efficient performance of your hydraulic circuits. Write us. Denison Engineering Division, American Brake Shoe Co., 1240 Dublin Road, Columbus 16, Ohio.

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

DENISON HydrOILics

NOW-A Better Rotary Joint!

SIZES
½" ¾" 1" 1¼"
1½" 2" 2½" 3"

NEW BARCO TYPE C Rotary Joint

Announcing...

It's new! It's simple! It's versatile! And for countless applications, Barco's new Type C Rotary Joint will give you the best operating records you've ever had.

FOR ALL SERVICES—One basic style of revolving joint for single flow or syphon flow ... one basic seal for steam, air, water, oil, gas—*or alternating hot and cold!* For temperatures to 450°F. Special to 500°F.

NO LUBRICATION NEEDED—Bearings and seal self-lubricating. Seal self-adjusting for wear. Long life without repairs or maintenance.

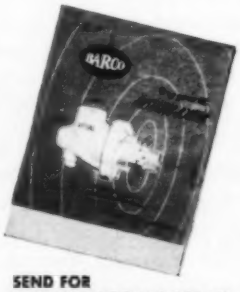
LOW TORQUE—Low starting and running torque*. Saves power. Suitable for any ordinary speed. To 200 psi, steam, or 400 psi, hydraulic.

COMPACT, SIMPLE—Malleable iron body; heat treated steel shaft; R.H. or L.H. thread. Eight sizes, ½" to 3".

**Typical example: 12 in. lbs. starting torque for 1" Type C on 100 psi water. Rotating torque, same.*

for

STEAM
WATER
OIL
AIR or GAS



SEND FOR NEW CATALOG 310 TODAY.

FOUNDED 1903 BARCO PRODUCTS BACKED BY EXPERIENCE

BARCO MANUFACTURING CO.
506N Hough Street • Barrington, Illinois

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints
In Canada: The Holden Co., Ltd., Montreal

Helpful Literature

for each grade. National Vulcanized Fibre Co.

Circle 434 on page 19

Hermetic Compressors

Specification sheets on four hermetic compressors cover 2, 3, 5 and 7½-hp models. Four bulletins list motor and compressor features, dimensions and performance. 2 pages each. Worthington Corp.

Circle 435 on page 19

Plastic Knobs

Standard instrument and control knobs, dials and assemblies illustrated and described in catalog 106 represent a line available from stock. They are produced in any thermosetting plastic material. Dimensional charts are featured. 16 pages. Kurz-Kasch Inc., Standard Parts Div.

Circle 436 on page 19

Time Delay Relays

Details on function of three basic time delay relays in ac, dc and 400-cycle types are found in illustrated bulletin AWH TD403. Time delay ranges are from 1½ seconds to 90 minutes. Wiring diagram, dimensions and other data are included. 2 pages. A. W. Haydon Co.

Circle 437 on page 19

Beryllium Copper Strip

"Heat Treating Curves for Beryllium Copper Strip" is title of bulletin No. 8. It presents heat treat recommendations to produce maximum strength and hardness. Hardness-response curves and specifications are included. 4 pages. Penn Precision Products, Inc.

Circle 438 on page 19

Large Nuts

Illustrated bulletin is devoted to large standard, jam and slotted nuts and line of locknuts. Large nuts are stocked in standard and special hexagon sizes. Specifications are given. 4 pages. Security Locknut Corp.

Circle 439 on page 19

Four-Cycle Engines

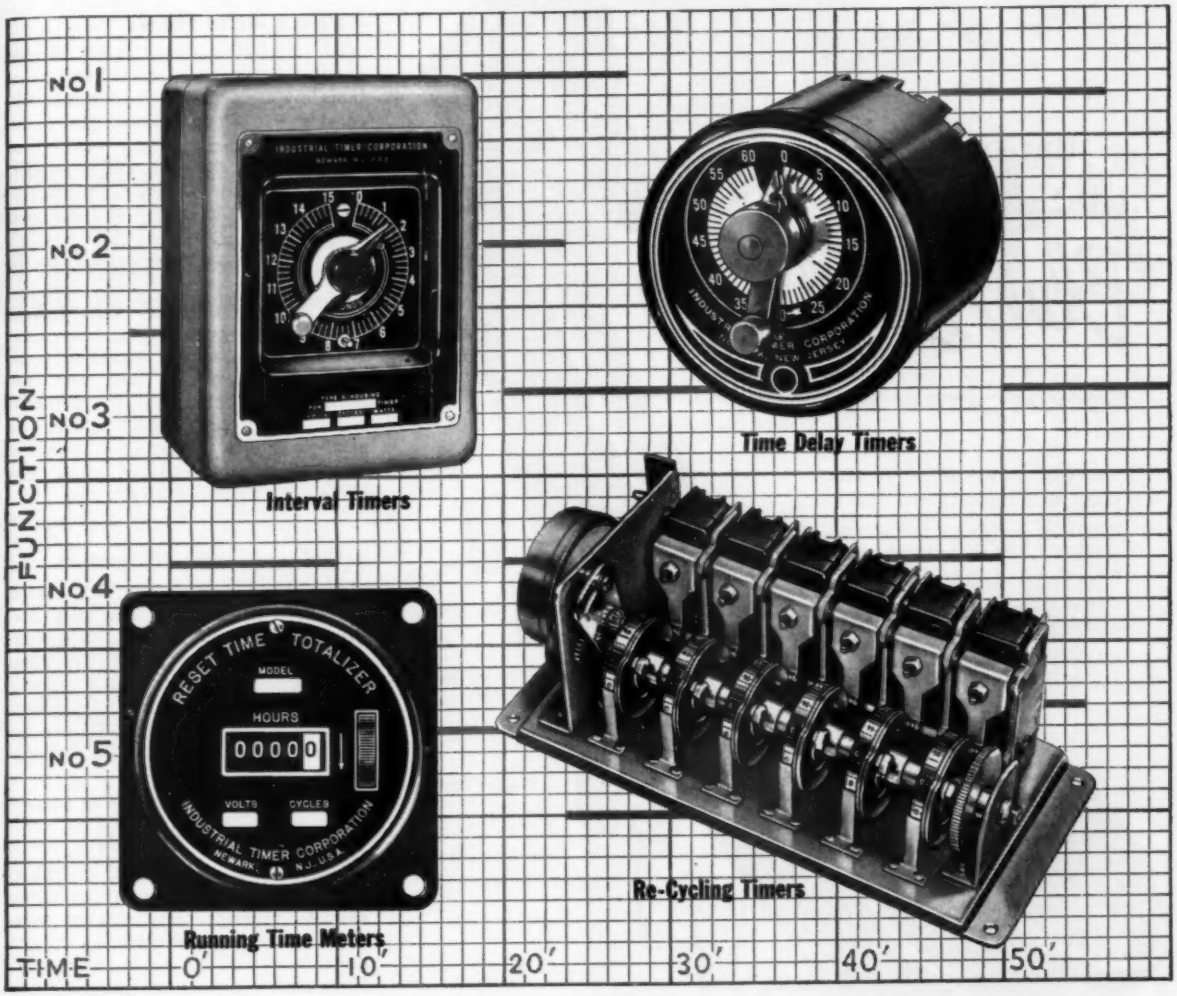
Four short - stroke four - cycle engines, with 1.8, 3.7, 8.2 and 15.0 hp at 1800 rpm, are subject of illustrated folder. Design features, specifications and optional features are described. Dimensional drawings are included. 4 pages. Kohler Co.

Circle 440 on page 19

V-Belt Drives

V-belt drive engineering manual is divided into three sections: V-drive

YOUR "SPECIAL" TIMER
may be one of our
721 STANDARD UNITS!



We have 20 years of experience in developing new timers to meet our customers' widely varying requirements. Our Engineering Department not only originates new designs, but also develops modifications for that purpose. That's why most requests for special timers can be filled without delay—by one of the 721 combinations we've developed so far from our 17 basic types of timers. But if we don't have what you want on hand, we'll welcome the chance to design and make it for you! And quickly too!

We manufacture a complete line of timers in these 4 broad classifications:

INTERVAL TIMERS • TIME DELAY TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

Our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. Ask us first—you may save yourself much lost motion... and your inquiry will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION
1413 McCARTER HIGHWAY, NEWARK 4, N. J.

Circle 583 on page 19

just one call
...that's all!
Blue Devil
Socket Screw Products
One call does it all . . . because your Blue Devil Distributor has a complete line of socket screw products. His large stock plus that of Blue Devil's factory and warehouse stocks means all your regular and emergency needs can be quickly filled. Why not call him today?
Socket Set Screws
Socket Cap Screws
Flat Head Cap Screws
Socket Shoulder Screws
"Saf-Lok" Socket Screws
"Led-Lok" Socket Cap Screws
Socket Pipe Plugs
Socket Screw Keys
Member ASMMA
ACTUAL CROSS-SECTION DIAGRAM
shows how cold forming of Blue Devil Socket head insures unimpaired fiber continuity.
Sold Only Through Authorized Industrial Distributors
SAFETY SOCKET SCREW COMPANY
6510 North Avondale Avenue • Chicago 31, Illinois
Warehouses at: Los Angeles • San Francisco • Detroit • New Haven, Conn.
Socket Screws Exclusively!
Circle 584 on page 19

Helpful Literature

selection, drive design and general information. Covered are determining required horsepower, belt speed, number of belts required and the right belt length. Much data are in table form. 66 pages. Maurey Mfg. Corp.

Circle 441 on page 19

Standard Metal Shapes

Die formed standard metal shapes adaptable to various mechanical functions are described and illustrated in catalog P3. Code analysis and index system provides an easy method of identifying 24 different shapes. Tabular data on each is given. 24 pages. Commercial Shearing & Stamping Co.

Circle 442 on page 19

Stainless Steel Sleeves

Centrifugally cast stainless steel sleeves, annealed for maximum machinability, corrosion and heat resistance, are available in standard cored bar stock sizes, as-cast or semi-machined. Properties, nominal strengths and available sizes are given. 4 pages. Vollrath Co.

Circle 443 on page 19

High Temperature Lubrication

Brief case histories in illustrated brochure 423 describe how 'dag' colloidal graphite, a high purity graphite dispersed in a variety of fluid carriers, is used for general high temperature lubrication application. Methods of increasing die life are described. 8 pages. Acheson Colloids Co.

Circle 444 on page 19

General Purpose Controls

General purpose control operation and application manual describes manual, magnetic and reduced voltage starters, pushbuttons, relays, limit switches, solenoids, and pressure and vacuum, float, plugging and antiplugging switches. Application data are included. 32 pages. General Electric Co.

Circle 445 on page 19

Bearings & Rod End Bearings

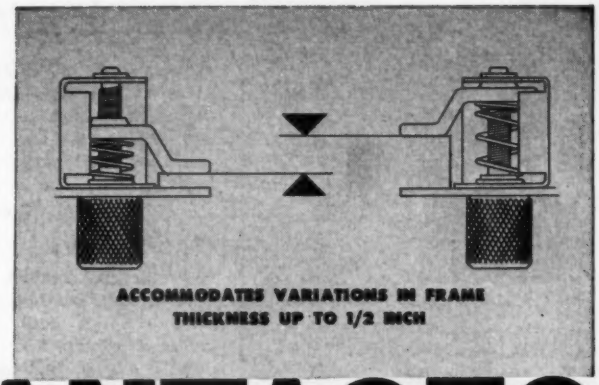
Spiral bound and illustrated catalog 551 on self-aligning bearings and rod end bearings contains dimensional drawings and complete specifications for entire line of these products. Service instructions are included. 42 pages. Southwest Products Co.

Circle 446 on page 19

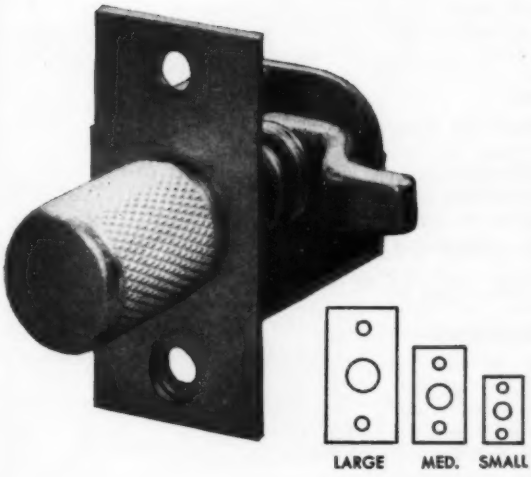
Pressure Sensitive Tapes

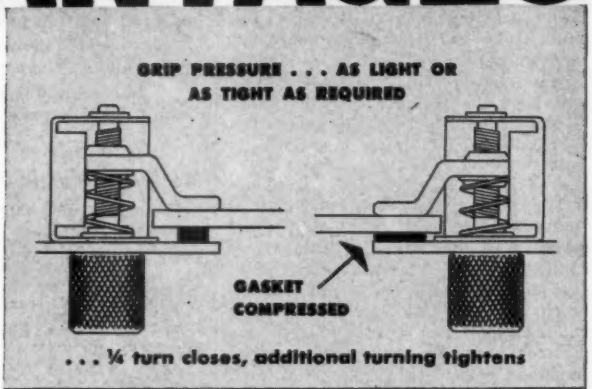
Multitude of ways to use tapes is disclosed in illustrated handbook. A

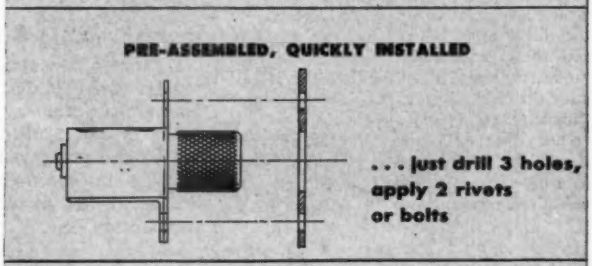
a family of door fasteners with

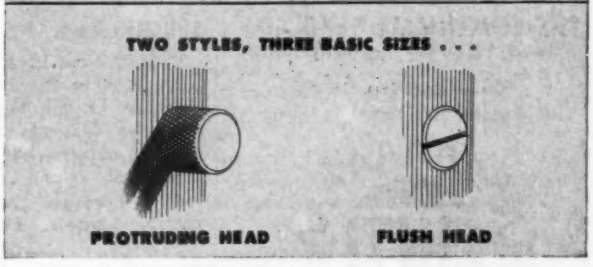


BIG ADVANTAGES









Get the complete story of Southco Pawl Fastener advantages. Write today for your copy of the Southco Fastener Handbook. Southco Division, South Chester Corporation. 237 Industrial Highway, Lester, Pa.

SOUTHCO FASTENERS

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LION

57 VARIETIES boiled down

L. A. Edwards

ASST. SALES MGR., THE CINCINNATI GEAR CO.

We could pass ourselves off as the Heinz of the Gear Industry by naming at least 57 different varieties of gears that we manufacture — but to be more concise, the gears we produce can be listed in eleven *basic* categories: spur, helical, rack, worm, herringbone, bevel, spiral bevel, internal, sprocket, Zerol* and Coniflex* (*Reg. U.S. Pat. Off.). This is still a pretty impressive list, we think, and covers just about all types in current demand for industrial use. Of course there are many variations within these basic types, too — such as a hypoid gear, which is basically a spiral bevel gear.

If you're one who has always thought that "gears is just gears," it will pay you to find out just what advantages each of these types has to offer. For instance, a straight bevel gear might perform *adequately* in an application that *ideally* calls for a Zerol gear; but fine points such as this can make the difference between *adequate* and *superior* results from your product. Your Cincinnati Gear Representative can cite advantages for the different gear types, and perhaps give you some ideas for applications in your products that you may have overlooked. And after the "right" gear has been chosen for your application, we can produce it for you — not only the right *kind* of gear, but with the "right" *quality* and *service* to assure your becoming another of our many satisfied repeat-order customers.

THE CINCINNATI GEAR CO.
CINCINNATI 27, OHIO
"Gears—Good Gears Only"

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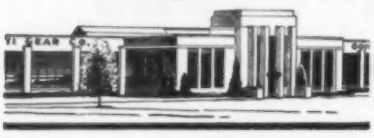

Circle 586 on page 19

Helpful Literature

"tape finder," aids in tape selection. Covered are masking, nonstaining, waterproof, high temperature, packaging, printable and other tapes and adhesives. 68 pages. Mystik Adhesive Products, Inc.

Circle 447 on page 19

Electric Motors

Protection against chemical corrosion, localized hot-spots and abrasive wear is built into Linc-Weld motors, described in illustrated bulletin SB-1345. All coils are hermetically sealed in thermosetting plastic. Design features and specs are given. 4 pages. Lincoln Electric Co.

Circle 448 on page 19

Lubricating Equipment

Modern lubricating equipment illustrated and briefly described in bulletin X-125 include oil cups, oiling systems, dispensers, valves and flow sights, liquid level gages and chain oilers. 4 pages. Oil-Rite Corp.

Circle 449 on page 19

Machined Plastic Parts

Examples of parts machined from Plexiglas, Micarta, nylon, Teflon, fiber, Celeron, Formica and other plastics are shown in illustrated folder. Company's production facilities are outlined. 4 pages. Engineered Plastics, Inc.

Circle 450 on page 19

Speed Reducers & Gearmotors

Design modifications as well as construction details of line of Slo-Speed gear motors, Slo-Speed motor reducers and Multi-Mount speed reducers are portrayed in bulletin 191. Factors in speed reducer selection are listed. 12 pages. Sterling Electric Motors, Inc.

Circle 451 on page 19

Ball Bearings

Contact-type Plya-Seal as now incorporated in the Fafnir wide inner ring line of ball bearings keeps out excessive amounts of contaminants even at slow speeds, while retaining supply of grease. Dimensions and load ratings are given in descriptive folder. 6 pages. Fafnir Bearing Co.

Circle 452 on page 19

Wrought Washers

All sizes of light steel washers, machinery bushings and expansion plugs, as well as AN, bevel, square, brass, narrow rim, special, countersunk finishing carburized and spring tension washers are listed in catalog 40. Wrought Washer Mfg. Co., 2100 S. Bay St., Milwaukee 7, Wis.

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PRECISION MANUFACTURING IS YOUR REQUIREMENT

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Boehme practical experience
in the design and
manufacture
of mechanical, electrical
and electronic products
for automation and
instrumentation can
solve your
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HOB

Circle 587 on page 19

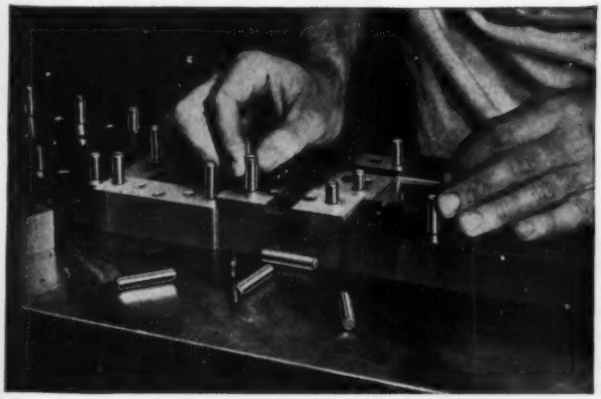
"STOCK ANSWER"
to many a design problem

ALLEN DOWEL PINS

ALLEN DOWEL PINS are being profitably employed in a thousand and one ingenious ways beyond their conventional applications in tool and die work — as economical roller bearings, as axles, precision plugs, hinges and wrist pins to name a few.

If you have an application that will utilize the great strength, accuracy and fine finish of Allen Dowel Pins, you can save substantially on the cost of your product — because you can secure them at favorable prices right from your Allen Distributor's stock.

Check the quick facts at the right and write directly to Allen's Engineering Department for further technical information.



SPECIFICATIONS

- Made from Allenoy heat treated steel. Surface hardness 62-64, Rockwell C scale; core hardness 52-54. Case depth .010″ to .020″ depending on size.
- Single shear strength 160,000 to 180,000 p.s.i.
- Surfaces precision ground to ± .0001″ with micro-inch finish of 6 RMS max.
- Sizes: Diameters, ⅛″ to 1″. Lengths, ⅜″ to 6″.
- Two standard oversizes — .0002 for press fits between mating parts, or .001 for repair work, or holes machined oversize.

ALLEN HEAD

ALLEN

MANUFACTURING COMPANY

Hartford 2, Connecticut, U.S.A.

Circle 588 on page 19

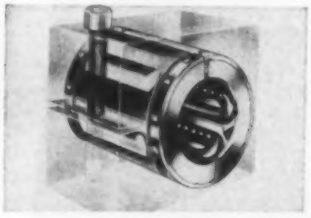
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Ball Bushing

is adjustable for wear or shaft size

Adjustable diameter ball bushing is split longitudinally and designed to provide line-to-line or slight preload fits when mounted in split housings. Construction eliminates need for selective assembly normally required to obtain no-clear-



ance fits because of tolerances on housing bore, bearing bore and shaft diameter. Design also permits compensation for wear which may develop in severe applications. Unit is available in standard bore sizes from 1 to 3 in. **Thomas Industries Inc.**, Manhasset, N. Y.

Circle 453 on page 19

Vacuum Pressure Switch

withstands high vibratory conditions

Vacuum pressure switch maintains fault-free performance under environmental conditions encountered

in aircraft and missile systems. Switch responds to pressures as low as 2 in. Hg absolute, retains accuracy to ±1 in. pressure under extreme environmental conditions and has a rigid miniature bellows supported to resist self-actuation under vibration up to 2000 cps at 10 g. Switch is available in models for use in inert-gas vacuum, fluid vacuum and absolute pressure. Weight is less than 3 oz; length is 3½ in. **Gorn Electric Co., Gorn Aircraft Controls Co.**, 845 Main St., Stamford, Conn.

Circle 454 on page 19

Pipe Strap

snaps onto pipe, speeding assembly

Snap-on strap for pipe, cable, and conduit snaps on, leaving assembler's hands free. Detent inside strap causes strap to spring slightly when assembled and holds it in place during assembly or installation operations. Straps are of heavy gage zinc-plated steel, in sizes for ½-in. through 2 in. thin

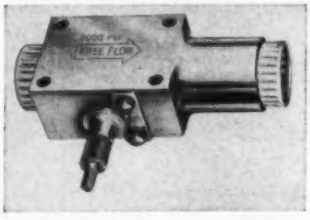
wall conduit and ⅜-in. through 2 in. pipe. **Holub Industries Inc.**, Sycamore, Ill.

Circle 455 on page 19

Check Valves

for heavy-duty use at 3000 psi pressure

Rotary-type controllable check valves, designated Series 5900, are available in three styles for tubing sizes of ¼, ½ and ¾-in. OD. Designed for heavy-duty applications at 3000 psi pressure, they can also be used as shut-offs for piping gasoline and lubricating oil, and for zero-leakage sequence operation. The valves, which have an aluminum alloy housing and stainless-steel internal parts, have no leakage at 3000 psi and 1 drop per minute at 5 psi. Liquid temperatures from 65 to 160 F can



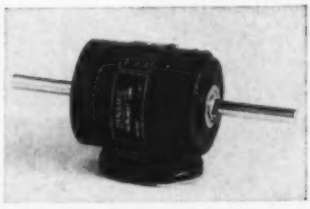
be handled. Valves weigh from 0.37 to 0.87-lb and have handle torques from 45 to 90 in.-lb. They conform to MS-28880 and exceed MIL-V-5528. **Aircraft Products Co.**, Tactair Valve Div., 300 Church Rd., Bridgeport, Pa.

Circle 456 on page 19

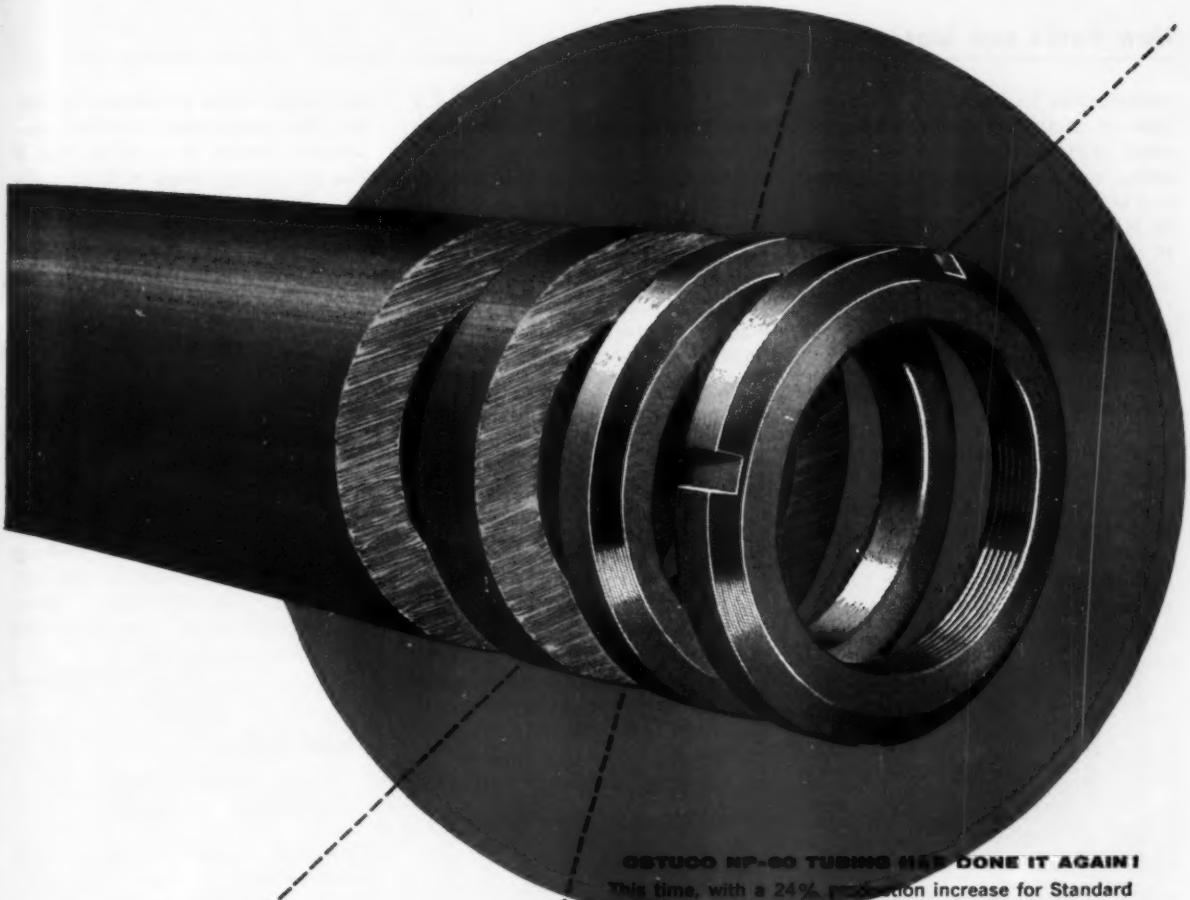
Friction Clutch

delivers minimum of 50 oz-in. torque

Magnetic friction clutch which meets military environmental and performance specifications has ap-



plication in low-power servomechanisms. It operates on 24 v dc, delivering a minimum of 50 oz-in. torque. Response time is within 3



24% Production increase at Standard Locknut & Lockwasher, Inc. after switching to OSTUCO NP-60 tubing

OSTUCO NP-60 TUBING HAS DONE IT AGAIN!

This time, with a 24% production increase for Standard Locknut & Lockwasher, Inc., Indianapolis, Indiana. Tubing experts from OSTUCO recently recommended a switch to NP-60 Tubing specially processed for machineability for Standard's locknut and lockwasher line used in ball and roller bearing applications.

Standard components find their way into electric motors, machine tools, automotive, aircraft, farm and construction equipment. Other companies, with equally diverse applications, report similar success with NP-60. If you are machining bearings, washers, collars, or any circular part, you'll do well to check into the merits of OSTUCO's new NP-60 seamless steel tubing.

GET NP-60 WITH "SINGLE-SOURCE SERVICE."

New NP-60 seamless tubing comes to you with OSTUCO'S unique "Single-Source Service"—experience and facilities for design and development, production and delivery all under one roof. Get together with a tubing expert for preliminary planning on NP-60's possibilities in your product. Contact your nearest sales office or write direct to the factory.

OSTUCO SHELBY, OHIO

OSTUCO TUBING

SEAMLESS AND ELECTRIC RESISTANCE WELDED STEEL TUBING—Fabricating and Forging

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • **SHELBY, OHIO**
Birthplace of the Seamless Steel Tube Industry in America

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CANADA, RAILWAY & POWER ENGR. CORP., LTD.
EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY
225 Broadway, New York 7, New York

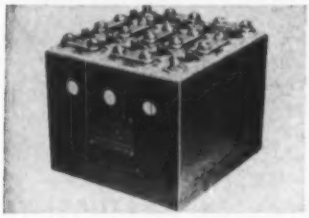
milliseconds. Unit introduces 2 minutes maximum angular displacement error into the system upon engagement. Power consumption is 3 w. **Dynamic Instrument Corp.**, 59 New York Ave., Westbury, L.I., N. Y.

Circle 457 on page 19

Nickel-Cadmium Batteries

miniaturized units from ½ to 150 amp-hr

Miniaturized nickel-cadmium sintered plate storage batteries have capacities from ½ to over 150 amp-hr and provide high cranking currents for engine starting in off-highway vehicles and other heavy motorized equipment. Batteries deliver momentary discharge cur-



rents as high as 25 times rated amp-hr capacity. Capable of repeated cycle service, units have a temperature range from −40 to 165 F. Units require little maintenance and may be stored indefinitely in any state of charge without deterioration or danger of freezing. Corrosive fumes are not emitted, and pressure release plugs prevent electrolyte spillage. **Nickel Cadmium Battery Corp.**, 68 Pleasant St., Easthampton, Mass.

Circle 458 on page 19

Prefinished Metals

have clear synthetic protective coating

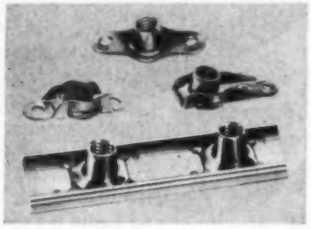
Baked synthetic protective coating for Nickeloid prefinished metals in copper and brass finishes contains a thermosetting resin with excellent film properties. In 48-hour salt spray tests using preplated copper steel, film showed 80 to 90 per cent better resistance than ordinary lacquer. Film is baked and cured under high heat to provide a tough, adherent elastic film which provides maximum gloss, flexibility, chemical and abrasion resistance. Metals coated with the film can be drawn, stamped, roll formed and seamed without peeling, cracking or flaking of the film. Applications are door hardware, switch plates, light fixtures, housewares, and other functional and decorative purposes where a protected copper or brass finish is necessary. **American Nickeloid Co.**, 14 Second St., Peru, Ill.

Circle 459 on page 19

Self-Locking Fasteners

meet requirements of NAS 680-695 drawings

Reduced height, counterbored, self-locking anchor and gang channel nuts are designed with minimum envelope dimensions compatible with performance requirements for structural aircraft applications. Having reduced width and weight, LHTA Series fasteners develop full



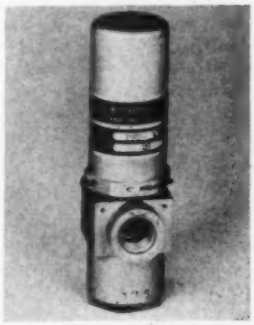
tensile, vibration, twist-out and push-up requirements of MIL-N-25027 (ASG). The heat-treated carbon steel fasteners perform satisfactorily at temperatures to 550 F. They are approved to AN-N-10, drawings AN 362 and AN 366, and meet the requirements of the new NAS 680-695 drawings. Current thread sizes are 8-32, 10-32, ¼-28 and 5/16-24. **Elastic Stop Nut Corp. of America**, 2330 Vauxhall Rd., Union, N. J.

Circle 460 on page 19

Pressure Reducer

regulates pressures to 3000 psi

Small, lightweight pneumatic pressure reducer is available in ¼ and ⅜-in. tube sizes. It is completely balanced, producing straight line regulation, with leaktight shut-off, rated capacity of 3000 psi and small initial pressure drop under flow conditions. Normal temperature range is −65 to 225 F The unit is furnished with or with-



out a built-in relief valve. Reducer weighs from 0.4 to 0.6-lb, and conforms to MIL-R-8572A. **Pneu-Hydro Valve Corp.**, 364 Glenwood Ave., East Orange, N. J.

Circle 461 on page 19

Liquid Sealant

for production locking of threaded fasteners

Locktite sealant automatically hardens between mating metal surfaces, eliminating the need for lock washers and lock nuts. Sealant holds fasteners in any position on the threaded length, does not score threads, and seals the seating surfaces against dirt, corrosion and fluid pressure. It is available in a 50 cc plastic bottle, primarily intended for multiple application by tumbling, brushing or dipping. An applicator nozzle is supplied for individual application. Sealant can be stored safely in the plastic bottle for extended periods of time. **American Sealants Co.**, Hartford, Conn.

Circle 462 on page 19

Sintered-Brass Nuts

have tensile strengths to 35,000 psi

These sintered-brass hex nuts are made to any desired shape, to very close tolerances, and with tensile strengths of 30,000 to 35,000 psi. They are available in widths from 5/32 to 9/16-in. and thicknesses from 3/64 to 19/64-in., in a wide range of hole and thread sizes. The nuts are finished in bright brass,

NEW *Synduction* MOTOR

Do you have an Application Requiring . . .

. . . Constant speed, regardless of load or voltage, depending only on frequency.

. . . Synchronized speed for a number of motors.

. . . Adjustable speed with minimum variation at any speed setting.

Synchronous Speed with Induction Simplicity

Allis-Chalmers new development — the *Synduction* motor — offers these characteristics at low cost — with the dependability of an induction motor. In addition to constant speed from no load to pull-out, it also offers across-the-line starting, wide range of speeds and high efficiency. It's another example of MORE motor pioneering by Allis-Chalmers.

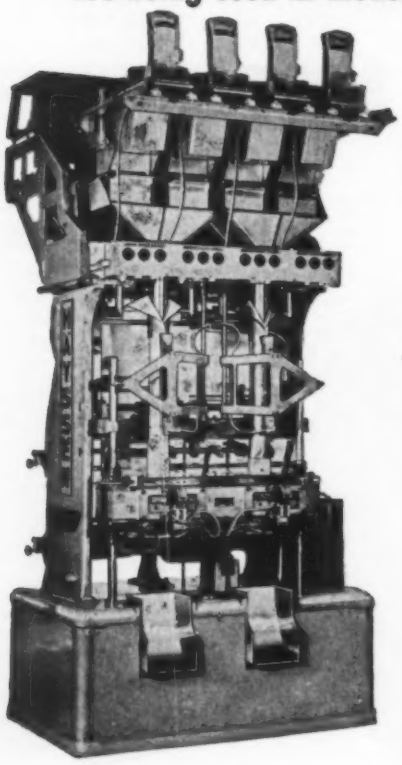
Allis-Chalmers invites your inquiry, in the belief that many processes can be improved by the application of *Synduction* motors. Our engineers will gladly analyze your present operations to help you determine where *Synduction* motors can be applied profitably. Call your A-C office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin, for Bulletin 51B8440.

Synduction is an Allis-Chalmers trademark.

A-5115

ALLIS-CHALMERS

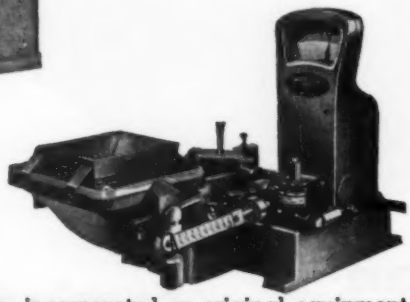
ONE MORE EXAMPLE of how EXACT WEIGHT Scales are being used in modern machinery design



Model 610
Net Weigher*

NOW

EXACT WEIGHT SCALES CONTROL ACCURACY IN HAYSSEN PACKAGING MACHINE



The EXACT WEIGHT Scales, incorporated as original equipment in the Hayssen Model "F" Compak Automatic Packaging Machine, control each filling operation with accuracy heretofore unattainable.

Weigh Feeders, developed by EXACT WEIGHT as original equipment for HPM Plastics Injection Molding Machines, provide more accurate measurement than is possible with volumetric feed.

EXACT WEIGHT Scales are now successfully used on milling machines to automatically weigh, balance, pre-set the machine and check the finished product.

EXACT WEIGHT Scales can be easily incorporated into the design of any machine that requires accurately controlled weight as part of its function.

Complete engineering data is available to designers. Write for free form #3305 to help you do a better job.

*The Net Weigher, shown above, is designed for original equipment installation. Write for complete details.

Exact Weight Scales

Better quality control
Better cost control

THE EXACT WEIGHT SCALE COMPANY

923 W. Fifth Avenue, Columbus 8, Ohio

In Canada: P.O. Box 179, Station S, Toronto 18, Ont.

New Parts

cadmium, zinc or nickel plating, or black oxide. They compare favorably in detail, dimensional control

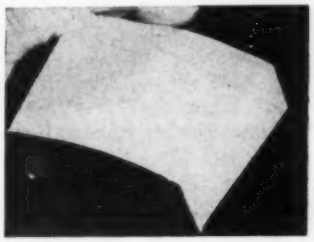
and mechanical properties with conventional brass nuts. **Midwest Sintered Products Corp.**, 13605 S. Halsted St., Chicago 27, Ill.

Circle 463 on page 19

Foam Polyethylene

for insulation or sound absorption

Expanded foam polyethylene known as Agilene-F, is available in semifinished molded shapes such as rings, blocks, rods, and sheet. Material may be used for heat and



electrical insulation, soundproofing, and similar applications. Specific gravity is 0.46 (or 0.33 if desired). Material is unicellular, very light in weight, extremely buoyant, readily compressed, and has tensile strength of 500 to 600 psi. **American Agile Corp.**, P. O. Box 168, Bedford, O.

Circle 464 on page 19

Check Valve

has protected O-ring seal

Protected-type 3000 psi stainless steel check valve has protected O-ring seal on valve poppet. Since the O-ring is protected from damage by flow turbulence or erosion, it may be any of a broad selection of synthetic materials. For example, low tensile strength silicone can be furnished for temper-

SIGHTS of rockets swooshing heavenward become more and more familiar as we thumb through today's industrial publications. The recalcitrant rocket shown on this page indicates that things *can* go wrong in research, and we don't claim that the absence of a Sanborn oscillographic recording system somewhere along the line was the reason for this disappointing trajectory.

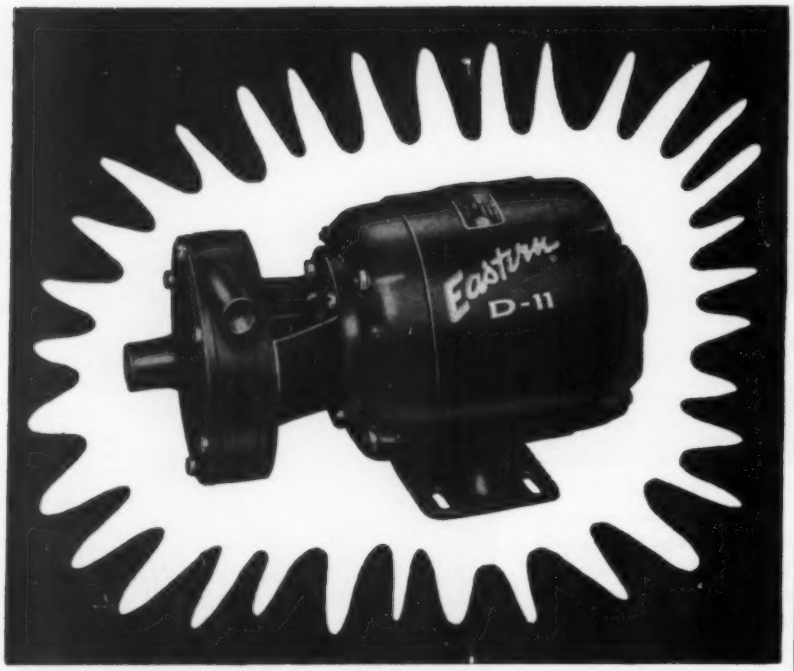
What we do wish to say is that Sanborn equipment is playing an increasingly vital part in rocket development. Used in the laboratory to record flight behavior simulated by analog computers, and in plotting rooms at testing bases to tape down telemetered data, Sanborn "150's" are helping rockets to get and stay where they belong.

You can see Sanborn systems in many other places, too. Oil fields, electronic component production lines, machine tool plants, hydraulic testing laboratories, numerous aircraft manufacturers, computing facilities . . . are putting single to 8-channel Sanborn systems to work. (Most are housed in vertical mobile cabinets, while those in the "field" are often divided into portable packages for each instrument.) All of them give their users inkless, permanent recordings in true rectangular coordinates, one percent linearity, as many as nine chart speeds, and the efficiency (and economy) inherent in Sanborn unitized design. A dozen different plug-in preamps further extend their value, by making changeover to new recording inputs a quick and easy procedure.

SANBORN COMPANY
CAMBRIDGE 39, MASSACHUSETTS

8-, 6-CHANNEL 4-CHANNEL 2-CHANNEL 1-CHANNEL 2-, 4-, 6-, 8-CHANNEL ANALOG COMPUTER SYSTEMS

Which way rockets are going may not be a primary concern of yours. But if recording problems are, you're apt to find some interesting and useful answers in Sanborn's 16 page "150 System" catalog. Write to us for a copy.



24,830 successful installations!

EASTERN D-11 CENTRIFUGAL PUMP

Why is the D-11 so successful among original equipment manufacturers? *Size and weight* make it ideal. The D-11 is the smallest, close-coupled, single-stage centrifugal pump available with an induction type motor. Eighteen pounds of compact design (9¾" x 4⅝") make it excel in industrial and process equipment, as well as laboratory service, and pilot plant operations.

SPECIAL METALS

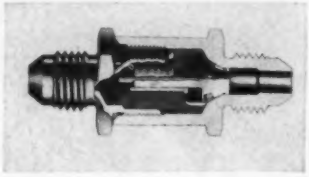
A full selection of metals make the D-11 and other Eastern Centrifugal Pumps versatile performers. Available in 18-8 Type 303 and Type 316 Stainless Steel, Monel, Hastelloy "C", Cast Iron and Bronze, Eastern Pumps range from ⅛th to ¾ H.P. with capacities up to 70 G.P.M., pressures to 65 P.S.I.

For complete specifications on all Eastern Centrifugal Pumps, request Bulletin 120-G

Eastern INDUSTRIES, INC.
100 Skiff St., Hamden 14, Conn.

New Parts

atures to 450 F; special seals can be furnished for red fuming nitric acid. Tube sizes are ¼, ⅜, and



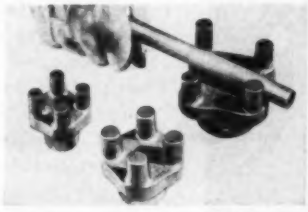
½-in. in two types: one for 37-deg flared tube fittings, the other for Ermeto-type fittings. **Mansfield & Green,** 1051 Power Ave., Cleveland 14, Ohio.

Circle 465 on page 19

Bar Knobs

provide heavy-duty handles for clamping

Four-pronged speed bar knobs are durable malleable iron and are easily turned by hand or with a bar or handle inserted between the prongs. Four models have extra



length prong for use with crank handle. Range of 15 threaded models provides sizes for all requirements. Knobs are for hold-down clamps, dogs, and cranks and handles on machine tools. **Jergens Tool Specialty Co.,** 712 E. 163rd St., Cleveland 10, Ohio.

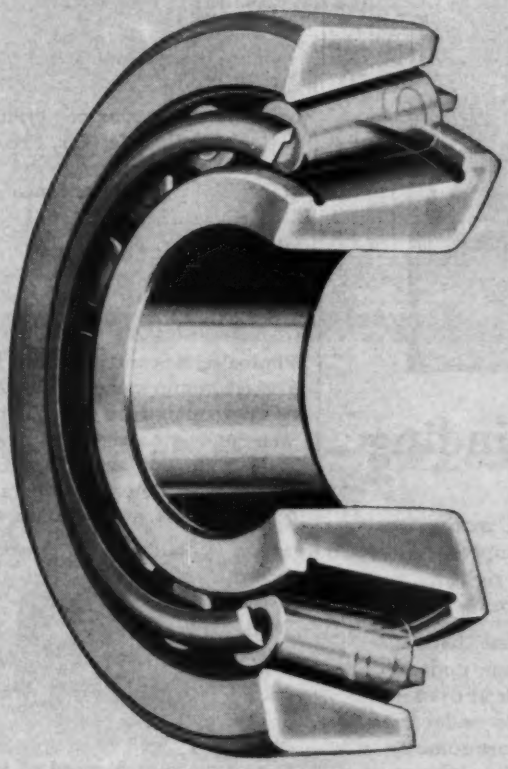
Circle 466 on page 19

Reverse-Reduction Unit

for use with 5 hp gasoline engines

Complete power control of gasoline engines is provided by this reverse-reduction unit, which incorporates a 2:1 reduction, definite neutral, positive forward and reverse. Double-acting precision clutch with over-center shift mechanism permits instant shifting from forward to reverse or neutral at any engine speed. Forward rotation is accomplished through a roller chain drive, reverse rotation

There's a BOWER TAPERED ROLLER BEARING engineered to fit your product



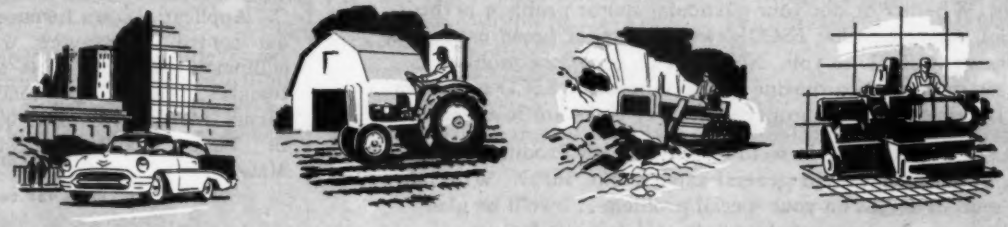
Types and sizes to fit a wide range of tapered bearing applications

There's no need to compromise with bearings! Whatever your product, if it uses tapered roller bearings, call in a Bower engineer for expert help on selecting the exact type and size you need.

Depending on your own particular needs, he'll make sure you get the exact size and type—selected from Bower's complete tapered line—engineered to assure maximum performance in your application.

Most important of all, when you specify Bower tapered roller bearings for your product, you get all the advantages of advanced Spher-O-Honed design—less maintenance, longer life, smoother operation. Get the full facts on the *complete* Bower line.

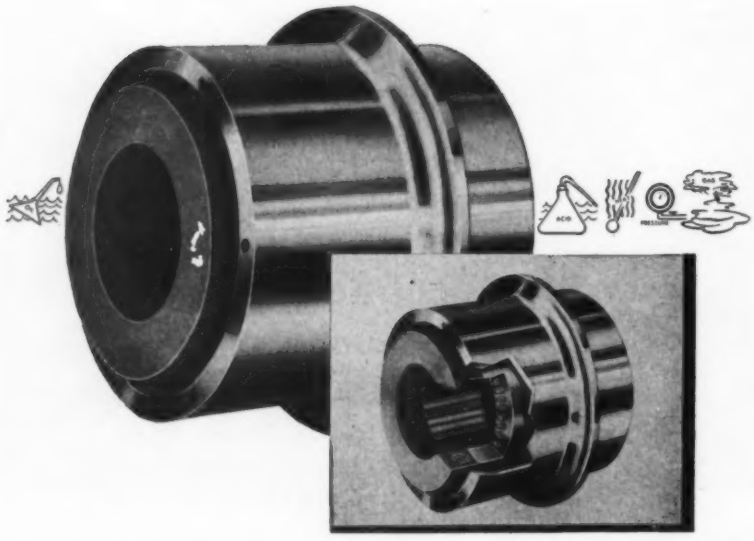
Tapered, Straight and Journal Roller Bearings for every field of transportation and industry



BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION • FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICH.

SPECIAL



nothing can touch this winding

Oil, acid, vapor, heat and pressure don't affect this AC motor winding. It's completely encased in a special, high-temperature, chemical-resistant plastic. The windings are cast right in the plastic to make a single, solid, impervious piece.

Of course, this winding goes into a special motor — one that's designed to run in a pressurized atmosphere of inert gas, under constant exposure to a piping-hot oil splash and vapor at over 200°F. Temperature-stabilized bearings, oil lubricated under pressure, and drip-proof, corrosion-resistant construction are some other design necessities for this unique 115-volt, 1/3 hp AC motor.

Here is a typical example of ESCO's unusual ability to design and build rotary electrical equipment to meet special customer needs. Whether or not your particular motor problem is this special, remember that ESCO's twenty years of broad experience is always available to you. No motor or generator problem is too big or small, too routine or specialized for ESCO engineers and craftsmen to solve properly, the way you want it solved.

Refer to Esco Catalog in section $\frac{4a}{E1}$ in Sweet's Product Design File, or write direct for general catalog No. 56PD. Why not also send us details on your special problem . . . we'll be glad to show you how we would go about solving it for you.

ESCO ELECTRIC SPECIALTY CO.
179 South Street, Stamford, Conn.

New Parts

through spur gears. The unit, designed for use with 5-hp, 3600-rpm engines, is fully enclosed and can

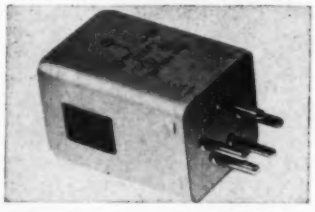
be bolted to engine crankcase. **J. B. Foote Foundry Co.**, Fredericktown, O.

Circle 467 on page 19

Photoelectric Control

operates at 5 ft-c or less

Photoelectric control utilizes broad-area cadmium sulfide photocell and relay, mounted on a 5-pin plug-in base and housed in a dust can measuring 1½ in. square by 2¼ in. high. Photorelay operates at 5 ft-c or less and releases at 0.1-



ft-c or more at a speed of two operations per second. Supply voltage is 115 v ac, 50/60 cycles, and temperature range is −40 to +75 C. Applications are furnace flame-out controls, conveyors, weighing equipment, machine tools and automatic packaging machinery. **Sigma Instruments Inc.**, 59 Pearl St., South Braintree, Boston 85, Mass.

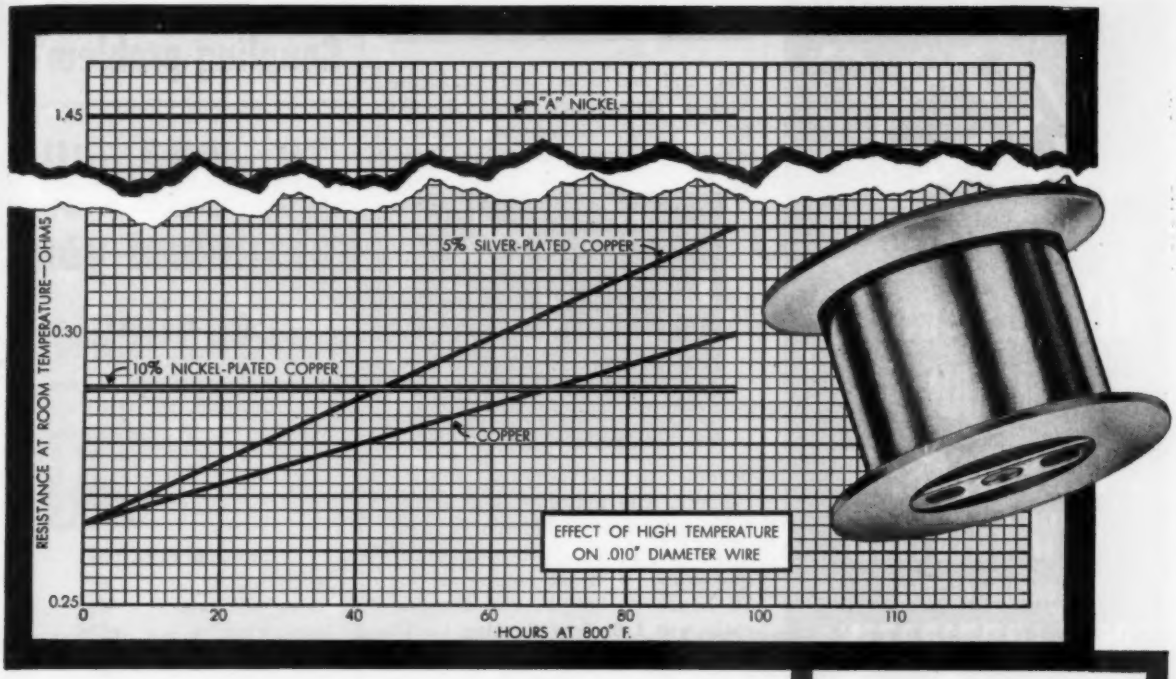
Circle 468 on page 19

Heat-Resistant Rubber

withstands swelling by aircraft fuels and oil

Silastic LS-53 fluoro-silicone rubber for use on jet-powered planes combines the properties of silicone rubbers and fluorocarbon plastics. It resists swelling in contact with jet fuels, gasoline, high aromatic

Circle 595 on page 19



Nickel-plated copper...

for high conductivity at elevated temperatures

SYLVANIA's Nickel-plated copper wire combines the conductivity of copper with the corrosion-resistant properties of nickel for applications involving temperatures ranging from 350° Fahrenheit to 700° Fahrenheit.

Equal lengths of Nickel-plated copper and three other wires were heated in air at 800° Fahrenheit for an extended period to determine the effect of heat on conductivity.

Nickel-plated copper, more than any of the other wires except for pure nickel, holds its original low resistance. It's this feature which, in many cases, has made Nickel-plated copper more desirable than costlier wires used where conductivity must remain constant under high temperature environment.

Nickel-plated copper wire can be supplied in a full range of diameters from .250" to .005".

Sylvania is the only major wire supplier with complete facilities for plating and cladding wire. This makes it possible to provide you with an experienced, objective recommendation as to whether a plated or a clad wire is best suited for your application.

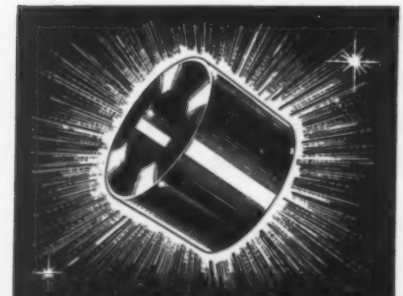
In addition, Sylvania's Parts Division offers you complete 4-way service including custom molded plastic parts, small metal parts ranging from wire forms to deep drawn parts, and special electronic components. Write for the "Portfolio of 4-way Service" and the new technical bulletin on Nickel-Plated Copper Wire.

SYLVANIA PARTS DIVISION

Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania

SPECIAL WIRE · METAL STAMPINGS · MOLDED PLASTIC · ELECTRONIC COMPONENTS

4-way service from one source



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GRAPHALLOY

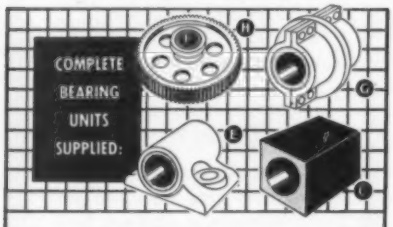
LONG WEARING
LOW FRICTION

UNIQUE (OIL-FREE)

SELF-LUBRICATING
BUSHINGS

EXCELLENT DURABILITY • CONSTANT COEFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE (−450° to +700°F.) OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE OR LIQUID GASES • NON-CONTAMINATING IN FOODSTUFFS • EXCELLENT FOR CURRENT-CARRYING BEARINGS

GRAPHALLOY is widely used for self-lubricating piston rings, seal rings, thrust and friction washers, pump vanes.



BRUSHES • CONTACTS

GRAPHALLOY has high-performance electrical properties: *low electrical noise, low and constant contact drop, high current density, minimum wear!*

Brush Holders and Assemblies, Coin Silver Slip Rings and Assemblies available.

USE OUR 40 YEARS OF DESIGN EXPERIENCE!

GRAPHITE METALLIZING CORPORATION

1045 Nepperhan Ave. • YONKERS, NEW YORK

☐ Please send data on Graphalloy Oil-Free BUSHINGS.

☐ Send data on BRUSHES and CONTACTS.

NAME & TITLE

COMPANY

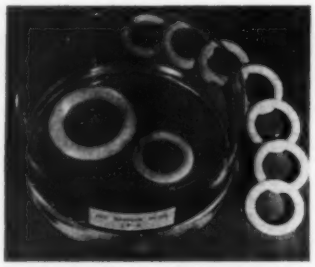
STREET

CITY ZONE STATE

Circle 597 on page 19

New Parts

oils and solvents, and performs over a temperature range of −80 to 400 F. Hardness, tensile strength and elongation are com-



parable to conventional silicone rubbers. The material is available fully compounded. Compared with a general purpose silicone rubber in contact with jet engine oil for 70 hours at 350 F, the swelling ratio was 1:6. **Dow Corning Corp.,** Midland, Mich.

Circle 469 on page 19

Multiplier Phototube

detects and measures ultraviolet radiation

Head-on type multiplier phototube is intended for detection and measurement of ultraviolet radiation and applications involving low-level radiation sources. Tube is constructed with fused-silica faceplate which transmits radiant energy in ultraviolet region down to and below 2000 angstroms. At 2000 angstroms, spectral sensitivity is over 50 per cent of maxi-

mum response. Spectral response covers range from 2000 to 6500 angstroms, with maximum response occurring at approximately 4400 angstroms. Features include semitransparent cathode having minimum diameter of 1⅝ in., ten electrostatically focused multiplying (dynode) stages, focusing electrode with external connection, and capability of multiplying feeble photoelectric current pro-

Coupling problem?

THOMAS will help select your coupling

DOUBLE FLEXING

DBZ—for high speed, heavy duty drives

SINGLE FLEXING

SS—for engine-driven generator sets with outboard bearings

DOUBLE FLEXING

AMR—for engine and medium speed drives

FLOATING SHAFT

BMR—for heavy duty service with excessive misalignment

Your Thomas Sales Engineer, backed by 40 years of coupling experience, will help you select the correct type Flexible Coupling from the Thomas catalog. Or, he will engineer special variations for unusual cases. For all practical purposes, properly installed and operated within rated conditions, Thomas Flexible Couplings will last *forever.*

NO LUBRICATION • NO MAINTENANCE
THERE ARE NO WEARING PARTS

Under load and misalignment, only Thomas Flexible Couplings offer *all* these advantages:

1. Freedom from backlash—torsional rigidity
2. Free end float
3. Smooth, continuous drive with constant rotational velocity
4. Visual inspection while operating
5. Original balance for life

Write for Engineering Catalog 51A and the name of the Thomas Flexible Coupling engineer nearest you.

THOMAS FLEXIBLE COUPLING CO.

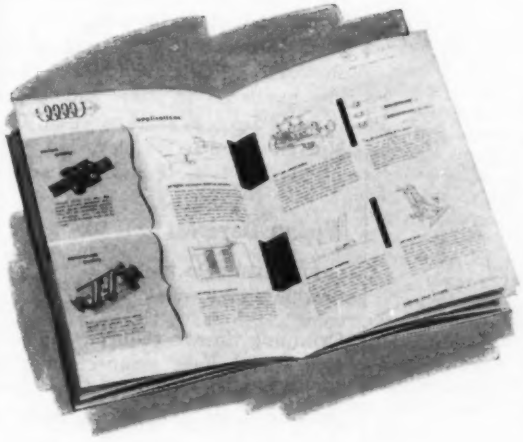
WARREN, PENNSYLVANIA, U.S.A.

Circle 598 on page 19

FREE! YOUR NEW ACTUATOR and SPLINE "PROBLEM SOLVER"!

New 1957 Engineering Data Book from World's Largest Producers of Ball/Bearing Screws and Splines

36 pages crammed with time-, work-, and money-saving facts: Principles • Types • Basic Operations • Coupling Methods • Efficiency • Versatility • Advantages • Selection Factors • Design Data • Sample Problems, etc.



SAGINAW b/b SCREWS are *90%-98% efficient* (compared to 15%-20% efficiency of Acme screws). Require ⅔ LESS torque and power for same linear output—with consequent weight, space reductions. Function normally at −75° to +250° F. Two types: precision-ground or commercial rolled-thread. Have been built 1½ in. to 39½ ft. long.

SAGINAW b/b SPLINES have *40 times lower coefficient of friction* than sliding splines; transmit or restrain high torque loads far better; permit vital power, weight, space reductions. Have been designed 3 in. to 10 ft. long.

Saginaw ball/bearing Screws & Splines

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

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Saginaw Steering Gear Division, General Motors Corporation
b/b Screw and Spline Operation
Dept. 1H, Saginaw, Michigan

Please send 1957 engineering data book on Saginaw b/b Screws and Splines to:

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ADDRESS_____

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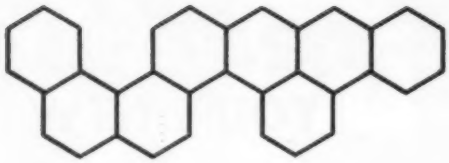


ANALYTICAL ENGINEERS

At Hawthorne, in Southern California, Northrop Aircraft has a continuing need for experienced engineers seeking new opportunities. There are attractive positions open in the following fields: Aerodynamics, Dynamics, Thermodynamics, Stress, Loads, Performance Analysis.

In Northrop's superbly equipped multi-million-dollar engineering and science center, now nearing completion, you will be given constantly fresh and challenging assignments. Present programs include Northrop's new supersonic trainer airplane, the Snark SM-62 intercontinental guided missile, plus advanced aircraft and missile projects yet to be revealed.

You'll be associated with a high-calibre engineering team that has established an outstanding record in aeronautical design and development. Your initiative and ideas will be recognized, encouraged and rewarded, for at Northrop Aircraft the progress of personnel is as important as the progress of projects.

Besides attractive remuneration, you will enjoy other benefits unexcelled in the entire industry—retirement plans, health and life insurance, college educational reimbursement plan, regular vacations plus extra year-end vacations with pay. Easily-reached mountain, desert and beach resorts in sunny Southern California offer year 'round attractions for you and your family.

You will find the career opportunity you are seeking at Northrop, pioneer in the design and production of all weather and pilotless aircraft. If you qualify for one of these attractive positions, contact the Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., ORegon 8-9111, Extension 1893, or write to: 1015 East Broadway, Department 4600 F, Hawthorne, California.

NORTHROP

NORTHROP AIRCRAFT, INC., HAWTHORNE, CALIFORNIA

Producers of Scorpion F-89 Interceptors and Snark SM-62 Intercontinental Missiles

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

5-A-89

New Parts

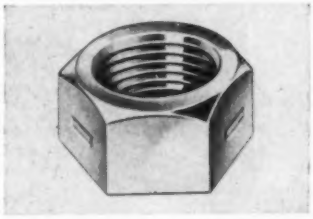
duced at cathode by median value of 400,000 times. **Radio Corp. of America,** Tube Div., Harrison, N. J.

Circle 470 on page 19

Lock Nut

double-chamfered unit has center locking

Lock nut can be applied from either end, is double chamfered, and has locking feature in center. Nut does not depend on friction against work or tightening torque for locking action and can be used on commercial or heat-treated bolts without damage to bolt threads and



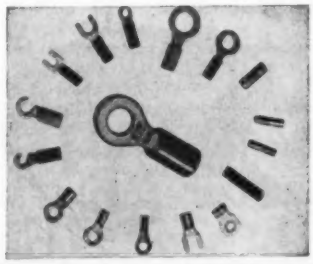
with maximum re - application torque. Controlled upward and downward displacement of central threads provides locking ability. Nuts are available in aluminum, brass and steel in sizes from ¼ thru ½-in., both fine and coarse threads. Single chamfered nuts are available in fine and coarse threads from 9/16 thru ⅞-in. **Grip Nut Co.,** South Whitley, Ind.

Circle 471 on page 19

Wiring Devices

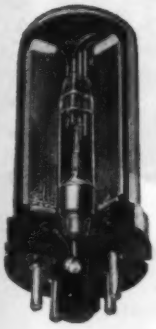
are available in wide range of styles

Crimping time is reduced and positive, permanent connections can be made with wiring devices which provide ¼-in. long target area for

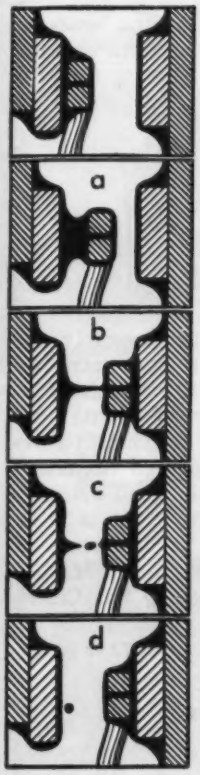


crimping tool, speeding production and reducing rejects. Wiring devices are one-piece soft copper, tin-electroplated for high conductivity

BILLIONS



OF OPERATIONS WITH **NO CONTACT WEAR OR BOUNCE**

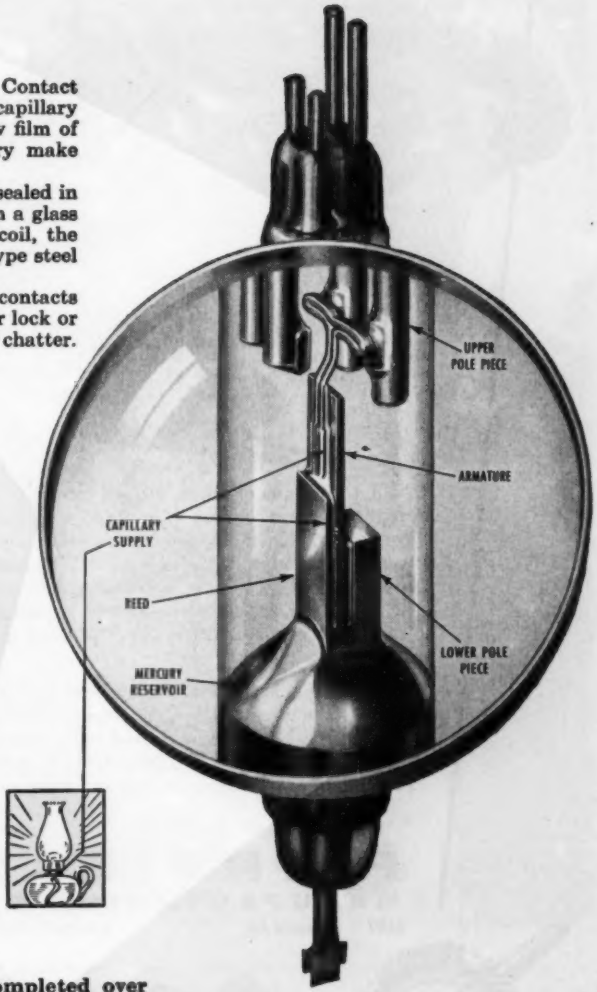


Contacts of CLARE Mercury-Wetted Contact Relays are constantly renewed. By capillary action, like that of a lamp wick, a new film of mercury coats each contact with every make and break.

The magnetic switch is hermetically sealed in a high-pressure hydrogen atmosphere in a glass capsule. Surrounded by the operating coil, the capsule is enclosed in a vacuum-tube-type steel envelope.

Unlike ordinary relay contacts, these contacts never wear down; never get dirty; never lock or weld; never get out of adjustment; never chatter.

Drawings (left) from stroboscopic photographs, show the cycle: (a) Filament of mercury forms between the contacts as they separate. (b) This becomes narrower in cross section and (c) finally parts at two points, allowing a globule of mercury to fall out. (d) The momentary bridging of the parting contacts—and the extremely fast break which ends it—minimizes the arc and adds greatly to contact load capacity. Contact closure between the two liquid surfaces bridges any mechanical chatter and prevents any chatter from appearing in the electrical circuit.



Relays on continuous test have completed over 3,000,000,000 operations with a contact load of 5 amperes at 50 volts—and are still going strong.

Send for Clare Engineering Bulletins Nos. 120 and 122. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare & Co., 659 Bayview Ave., Toronto 17. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

Circle 600 on page 19

For GEARS to build AMERICA'S ROADS

GEARS, thousands of them, will go into the construction machinery needed for our nationwide program of building highways and roads. An increasing number of these will be Fairfield Gears. Already one of America's largest independent producers, Fairfield's facilities are being further enlarged this year with approximately one hundred percent more space in heat treating and thirty-three percent more space for machine installations.

If you use gears in the product you make, we believe it will pay you, as it has others, to become acquainted with FAIRFIELD —the place where fine gears and differentials are produced to meet your specifications EFFICIENTLY, ECONOMICALLY! *Your inquiry will receive prompt attention.*

FAIRFIELD
MANUFACTURING CO.
2307 S. Concord Rd. Lafayette, Indiana

Fine Gears For FINE GEARS *Made to Order*

TRACTORS • CONSTRUCTION MACHINERY • ENGINES • BUSES • FARM IMPLEMENTS • MINING MACHINERY
DIESEL LOCOMOTIVES • MACHINE TOOLS • AIRPLANES • HEAVY DUTY TRUCKS • OIL FIELD EQUIPMENT

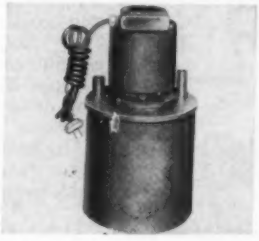
and maximum corrosion resistance. Devices are available in ring, spade, hook tongue, snap-plugs, flag-type, parallel, butt, 3-way Y, and 4-way X to fit wire sizes 22-16, 16-14 and 12-10. **Electric Terminals Corp.**, 2021 Center St., Cleveland 13, Ohio.

Circle 472 on page 19

Pump and Tank Assembly

high-capacity unit handles abrasive materials

No. 4072-T pump and tank unit handles abrasive materials such as silicon carbide solutions on honing, lapping and ultrasonic machines. There are no bearings, seals or packings in contact with material



being pumped. The assembly consists of a 1/10-hp centrifugal pump, tank with inlet and discharge connections, electric cord and plug. Motor is mounted above the tank lid. An even mixture of the liquid is maintained automatically in the tank. Tank is available in stainless steel or standard carbon steel. **Ruthman Machinery Co.**, 1811 Reading Rd., Cincinnati 2, O.

Circle 473 on page 19

Wire-Thread Insert

stainless-steel unit for integral thread casting

Stainless-steel insert, developed specifically for sand-casting operations, has application where durable, corrosion-resistant threads are required in cast-metal parts. It permits high-speed casting of integral threads. The insert is tightly wound to prevent flow of hot metal into female threads and to maintain correct thread pitch in the casting. Insert is placed directly in the mold on sand cores, and molten metal flows around it,

LONGER SOLENOID LIFE...

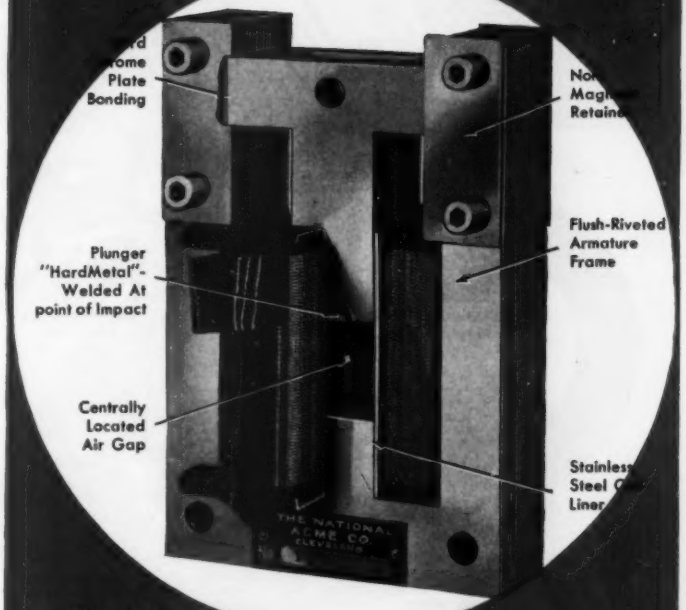
with NAMCO'S exclusive "HARDMETAL"-welded plunger bonding

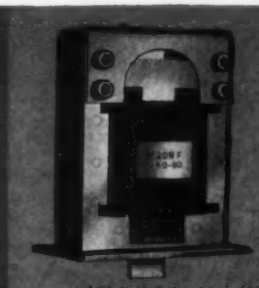
Standard or Custom Models To Fit Your Design

"HardMetal"-welded plunger bonding prevents mushrooming at the vital point of impact—withstands incessant pounding of the plunger on the frame. Long plunger life, and thus long solenoid life, is further insured by hard chrome plating upper guide edges of plunger laminations to reduce friction and wear.

Namco standard solenoids are available in six series of pull and push types; custom-engineered solenoids in every size and type can be made to meet your specifications.

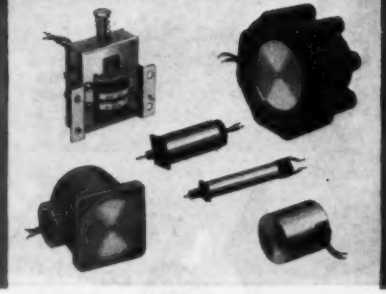
Standard "HardMetal"-Welded Solenoids are furnished push or pull type in sizes with ratings from 2-1/2 to 21 pounds at 1/2" stroke and from 2 to 25 pounds at 1" stroke.





← Saddle stop applied to Series K200 standard Namco push type solenoid.

To meet specific job requirements, solenoids of special shapes and sizes are designed and built through cooperation of our engineers with yours. →



Ask us to send a National Acme Representative to discuss your problems, or if you want more information first—send for BULLETIN EM-52.

ELECTRICAL MANUFACTURING DIVISION

National Acme

THE NATIONAL ACME COMPANY • 188 EAST 131ST STREET • CLEVELAND 8, OHIO

60 second tour

shows it in a nutshell . . .

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COMPRESSION SPRINGS
Regular, Double

COMPRESSION SPRINGS
Special Shapes
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EXTENSION SPRINGS
Special Hooks
and Loops

EXTENSION SPRINGS
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Single, double
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POWER SPRINGS
Clock or Motor

FLAT SPRINGS
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CLIPS, CLAMPS
and COLLARS

FASTENERS and
RETAINERS

HAIRSPRINGS
for Instruments
Gauges, etc.

SPRING WASHERS
Wavy, Star, Finger,
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BELLEVILLE SPRINGS
In Series, Parallel
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DIAPHRAGMS
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PLUS
COLD-ROLLED
SPRING STEEL

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BRISTOL
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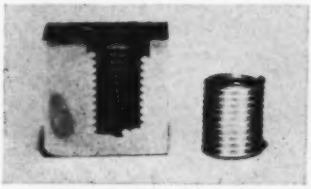
THE WALLACE BARNES CO., LTD.
HAMILTON
CANADA

Divisions of

ASSOCIATED SPRING CORPORATION

forming a fusion bond. After casting, sand is removed by blast cleaning, leaving the stainless steel threads. Since coils are flexible, stresses are not concen-



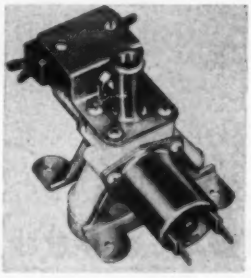
trated around the insert and cracking of the cast is avoided. **Heli-Coil Corp.**, Shelter Rock Rd., Danbury, Conn.

Circle 474 on page 19

Mixing Valve

adjusts water temperature by opening valves alternately

Three-temperature thermostatic water mixing valve supplies water of desired temperature. Valve utilizes externally mounted switch that alternately opens and closes hot and cold water solenoid valves



so rapidly that flow of water supplied is of uniform temperature. Unit is powered by a thermostatic element which supplies power to the switch controlling the solenoid valves as required to produce desired temperatures, either hot, cold, or a mixture. **Detroit Controls Corp.**, 5900 Trumbull Ave., Detroit 8, Mich.

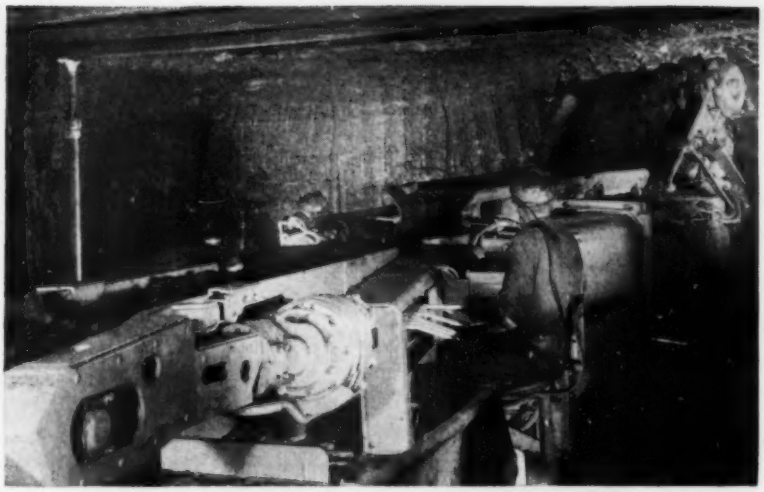
Circle 475 on page 19

Electromagnetic Clutch

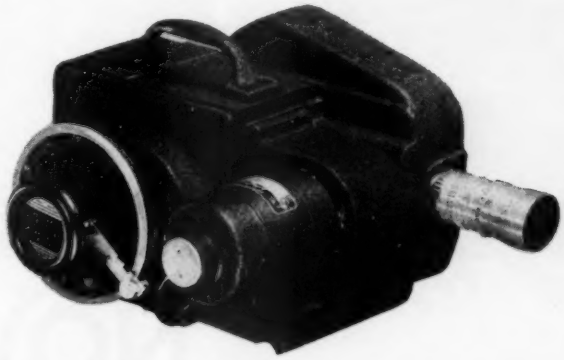
provides gradual engagement

Electromagnetic multiple disk clutch is designed for step by step acceleration of large masses in main drives, or as an auxiliary or feed drive for precise control

(*Continued on Page* 180)



This is a continuous coal miner in operation. Its maker, Joy Manufacturing Company, wanted to know how the cutter bits performed when cutting coal and pyrites. But the bits moved too fast to see.



This is a Kodak High Speed Camera. Joy engineers took it down in the company's coal mine laboratory and used it to take 16mm movies of the cutter bits in action at speeds up to 3200 frames a second.

When they projected the movies at a normal 16 frames per second, the action was slowed as much as 200 times on the screen. Then they could see the action of the cutter bits at different angles and positions in the holding chain, determine the best possible arrangement for maximum cutting efficiency.

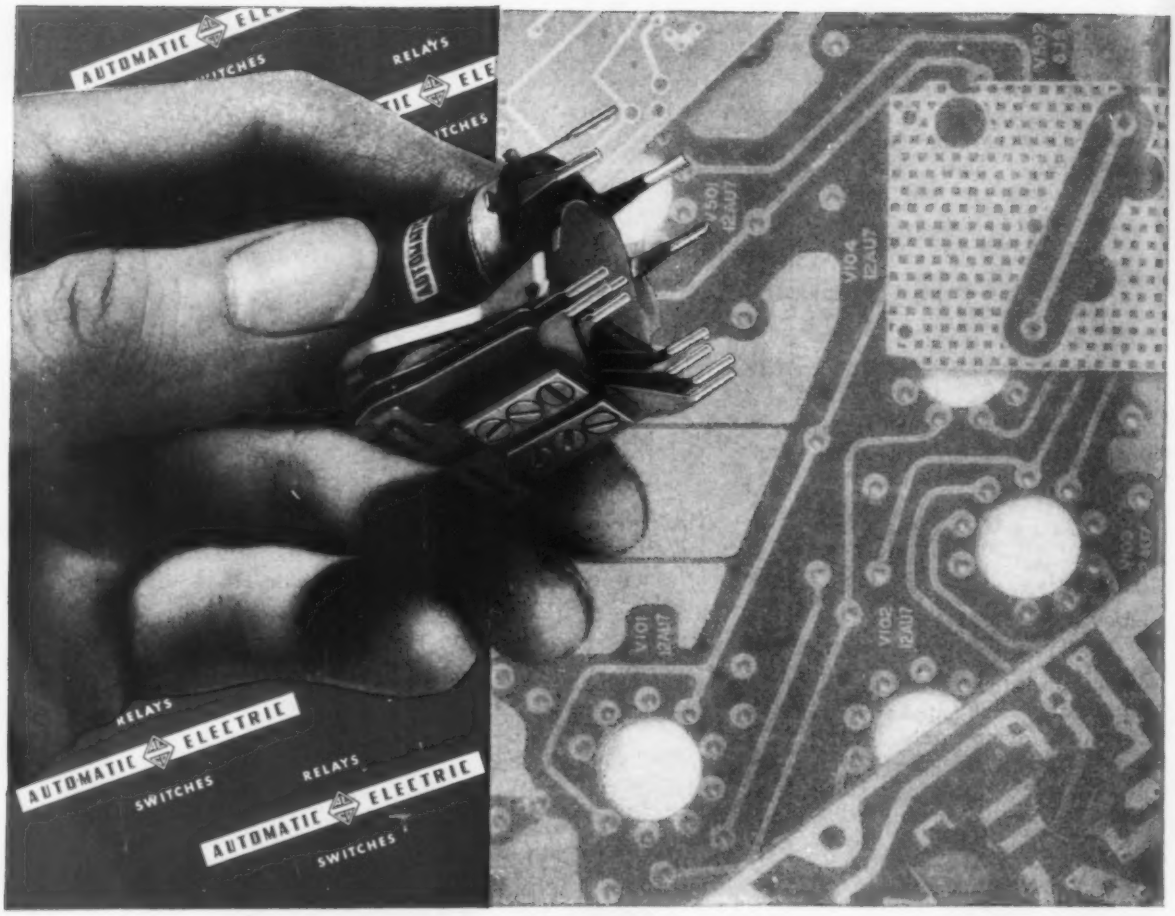
The Kodak High Speed Camera is a practical instrument for practical engineers who would rather see what's happening than waste time guessing. The booklet "High Speed Motion Pictures at the Service of the Engineer" will give you both information and ideas. For your copy write:

EASTMAN KODAK COMPANY, Rochester 4, N.Y.

the Kodak
***HIGH SPEED* Camera**

Kodak

Circle 604 on page 19



NOW!

dependable relays for printed circuits

Maybe you, too, have been awaiting availability of a *good* relay for direct insertion into printed circuits. Now Automatic Electric can solve your problem with a miniature relay that is just right.

120 million operations, without a single readjustment or relubrication! That's what you get from this rugged, improved Series SQPC Relay, because it features a special *heavy-duty* bearing and bearing pin. Also a recess in the bearing plate retains an adequate supply of lubricant for long-term lubrication of the bearing pin.

Consider these additional advantages:

1. The sections of the terminals that insert into the printed circuit board are NOT brazed or welded into place, but are integral parts of the coil terminals and contact springs—thus preventing internal loss in conductivity or continuity.
2. Terminal design permits direct plug-in of the relay into a printed circuit board, ready to be secured in place with any acceptable soldering technique.

Usually the desired contact spring combination, or pile-up, is sufficiently large so that additional mounting (support) of the relay is not necessary.

SQPC Miniature Printed Circuit Relays are available with many different contact spring arrangements, and for a multitude of applications. Springs can be made of phosphor-bronze, "Bronco" metal, or other special-purpose materials, as required.

Of course the long life, heavy-duty features of the improved SQPC Relay can be had in the conventional type of plug-in relay, if regular sockets are preferred for use, whether in printed circuitry or other applications.

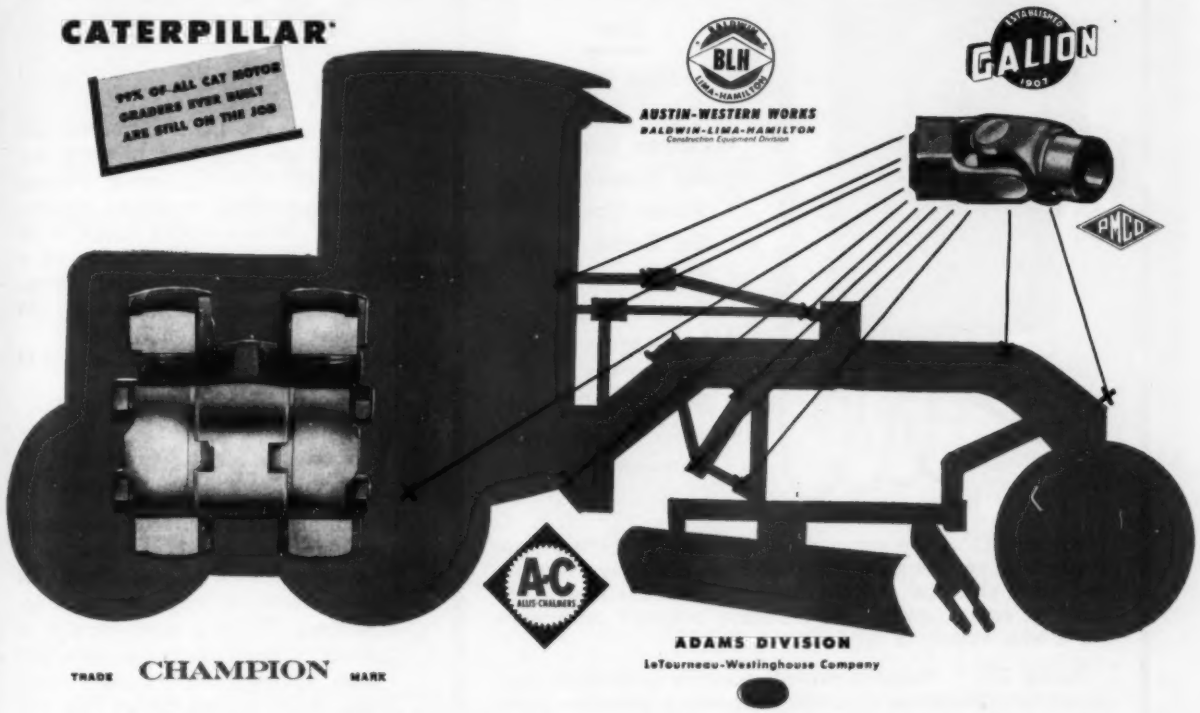
To get complete details, write: Automatic Electric Sales Corporation, 1033 West Van Buren St., Chicago 7, Illinois. *In Canada:* Automatic Electric (Canada) Ltd., Toronto. *Offices in principal cities.*

AUTOMATIC ELECTRIC

Originators of the dial telephone • Pioneers in automatic control

GENERAL TELEPHONE SYSTEM

RELIABLE



TRADE CHAMPION MARK

Whether for close-coupled main drive lines or for exposed steering and adjustment drives, designers with JOINT problems have learned to rely on MECHANICS. Where joints must run all day at high angles — where there are severe shock loads — where wide angles and long slip are common — and where dirt and/or moisture constantly are present — MECHANICS Roller Bearing UNIVERSAL JOINTS are the accepted solution. *Lubrication is so tightly sealed in that dirt and moisture cannot enter.* If you have a "tough" joint problem, make use of MECHANICS field engineers' wide experience.

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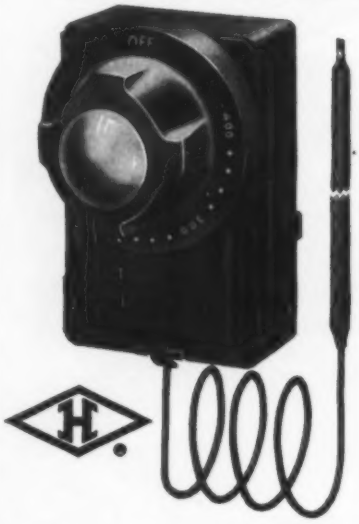
MECHANICS
Roller Bearing BW
UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

Circle 606 on page 19

Complete NEW Line of "Diamond H" Thermostats (Series 270)



For

- Grease Kettles
- Steam Tables
- Coffee Urns
- Air Conditioning
- Motor Control
- Oil Baths
- Platens
- Range Ovens
- Laboratory Equipment
- Solenoid Control
- And Many Other Applications

"Diamond H" engineering, noted for building better, more dependable performance into smaller space in relays, switches and other electrical and electronic controls, has now developed an entire new line of extremely compact thermostats for a wide variety of applications.

Series 270 thermostats provide accurate calibration, consistent low-differential operation and positive, over-the-center, quick action (to make or to break on rising temperature) in single pole, single throw and double pole, single throw models.

Circuits vary from simple on-off to special selector sequencing to meet special requirements, including single dial, automatic preheat operation for oven models. Temperature ranges are available to suit the application.

Some units may be equipped with terminals for remote pilot light connection; others with terminal clips for direct connection of pilots. Spade terminals simplify wiring.

UL approved standard ratings up to 25 A., 125-250 V., A. C., are available. Horsepower ratings up to 1 h. p., 120-240 V., A. C., special bulb and capillary lengths and sizes, together with special spindle and mounting arrangements, and dials in a choice of colors and marked to suit the customer, may also be obtained.

Descriptive bulletins T270 and T276H are yours on request. "Diamond H" engineers are prepared to work out your specific requirements with you. Tell us your needs.

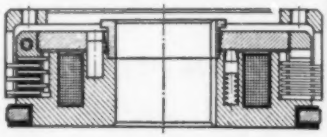
THE HART MANUFACTURING CO.

118 Bartholomew Ave., Hartford, Conn.

New Parts

(*Continued from Page 177*)

and quick response in machine tools and similar applications. Unit has small dimensions in relation to magnitude of torque. Magnetic flux does not pass disk bundle, so bundle can be designed and formed without regard to magnetic circuit



requirements. Disks of various materials can be paired to work dry or in oil, with surfaces of various types according to torque requirements. Torque rating range is 10 to 15,000 lb-ft. Voltage is 24 v dc. **McCauley Industrial Corp.**, Power Transmission Div., 219 Parker Ave., Dayton 7, Ohio.

Circle 476 on page 19

Corrosion Preventive

wax-base coating protects metals from severe exposure

Nonflammable corrosion preventive coating for metal surfaces is a water emulsion of waxes and oils in combination with corrosion inhibitors. When applied by dip or spray, material forms a uniformly firm, transparent, wax-type coating. After a brief drying and curing period, coating cannot revert to emulsion, and will not wash off. Coated parts remain protected under conditions of rain, sleet, hail and high humidity for over two months. Material resists fingerprint corrosion, whether metal parts are handled before or after application of coating. **Dearborn Chemical Co.**, Merchandise Mart Plaza, Chicago 54, Ill.

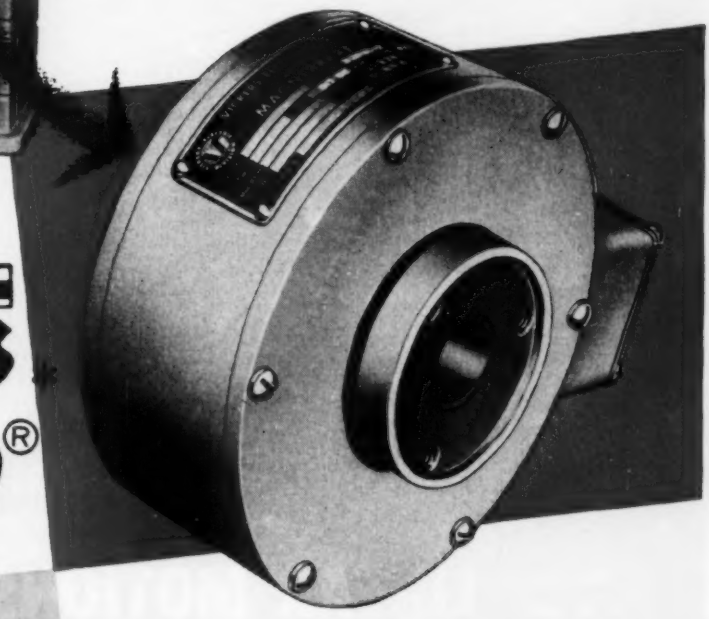
Circle 477 on page 19

Shaded-Pole Motor

reversible unit has low vibration resonances

Reversible shaded-pole motor designed for light commercial fans is available in ratings from 1/30 to 1/12-hp and offers reversibility comparable to that of capacitor motors of similar size and rating. Motor is designed to minimize vibration resonances and provides

FOR SMOOTHER QUIETER and MORE DEPENDABLE PRECISION BORING MACHINE OPERATION



EX·CELL·O uses the VICKERS Magnebrake®

DRY MAGNETIC-PARTICLE BRAKE

Ex-Cell-O Corporation of Detroit, well-known manufacturer of quality machine tools, equips its precision boring machines with Vickers MAGNEBRAKE, because this unique braking equipment provides the important advantages of . . .

- **LONGER, TROUBLE FREE LIFE,** requiring much less brake maintenance than ordinary friction-type braking systems . . . thereby minimizing and in some instances, eliminating machine down-time. There are no shoes or linings in Vickers MAGNEBRAKES – nothing to wear out – your assurance of far longer, trouble free service life.
- **SMOOTHER, FASTER, QUIETER PERFORMANCE,** without troublesome grab or chatter. Since torque is independent of speed in the MAGNEBRAKE, stops are far smoother . . . thereby preventing transmission of brake vibrations through the spindle and to the work.

Vickers MAGNEBRAKES can serve you with the efficiency, dependability and durability needed for today's faster working duty cycles, higher operating speeds and higher inertia loads. Vickers engineers are thoroughly experienced in the application of industrial clutches and brakes. They will be happy to examine your problem and to offer competent engineering advice, without obligation. Write today for more detailed information.

*TRADEMARK

DESIGN ENGINEERS: There are openings in our expanding program. Write for details.

VICKERS ELECTRIC DIVISION

VICKERS INCORPORATED a unit of Sperry Rand Corporation

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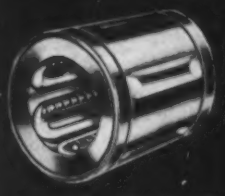
Circle 608 on page 19

NOW! *Adjustable Diameter and Open*
THOMSON
BALL BUSHINGS

Adjustable Diameter
BALL BUSHING for Zero Clearance

The BALL Bearing for *all* your **LINEAR MOTIONS**



Precision Series "A" and
Low Cost Series "B" BALL BUSHING.

Open BALL BUSHING
for Zero Clearance on
Supported Shafts

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers and designers have solved this problem by application of BALL BUSHINGS on *guide rods, reciprocating shafts, push-pull actions,* or for support of *any mechanism that is moved or shifted in a straight line.*

Improve your product! Up-date your design and performance with Thomson BALL BUSHINGS!

LOW FRICTION · ZERO SHAKE OR PLAY
ELIMINATE BINDING AND CHATTER
SOLVE SLIDING LUBRICATION PROBLEMS
LONG LIFE · LASTING ALIGNMENT

The various types cover a shaft diameter range of ¼" to 4". Small sizes available in Stainless Steel. Write for literature and name of our representative in your city.

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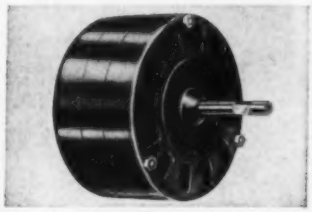
Dept. E, MANHASSET, NEW YORK

Also manufacturers of NYLINED Bearings
. . . Sleeve Bearings of DuPont NYLON

New Parts

essentially flat noise characteristics from 25 to 1500 cps. Features include laminations designed for low leakage flux, high copper-to-iron



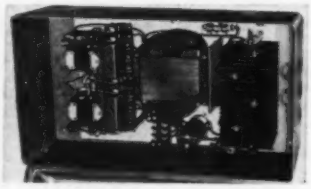
ratio and die-cast rotor structure for maximum uniformity of rotor resistance. **Fasco Industries Inc.,** 255 N. Union St., Rochester 2, N. Y.

Circle 478 on page 19

Braking Controller

for ac motors
is packaged unit

Packaged control and braking system fits any standard ac motor. Electrical braking torque diminishes as motor decelerates until smooth, definite stop results, normally in same time required for



acceleration of driven equipment. There is no possibility of reversing. Braking controller is available with braking unit only, or as complete braking and starting unit for either nonreversing or reversing service. Circuit breaker, disconnect, and other modifications are available. **Westinghouse Electric Corp.,** P. O. Box 2099, Pittsburgh 30, Pa.

Circle 479 on page 19

Solenoid

lightweight unit
has ⅜-in. stroke

Solenoid, meeting requirements for a small, light, economical actuator, is designed for both continuous and intermittent duty in industrial and commercial use. Suitable for ac and dc applications in automatic machines requiring a moderate amount of power, such as record-

Circle 609 on page 19

Gardner-Denver . . . Serving the World's Basic Industries

Gardner-Denver 5-cylinder, radial air motor.

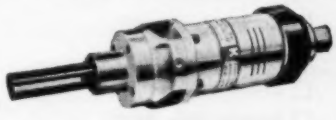
Keep your eye on the inside . . . when specifying air motors

Here's one product you can specify and forget when it comes to compressed air powering. Precision workmanship applied to top-quality materials is the reason. Gardner-Denver multi-use air motors excel in safety, control flexibility, high torque and freedom from overload damage.

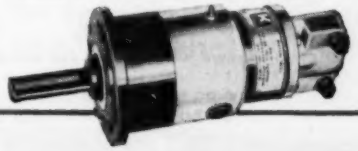
5 sizes; 3 to 16 h.p. . . . direct drive or built-in gear reduction . . . reversible or non-reversible—a choice of power and speed for many applications.

JUST A FEW JOBS WHERE GARDNER-DENVER AIR MOTORS PUT IN A FULL DAY'S WORK: Bit Grinders • Bending Rolls • Grout Mixers • Concrete Mixers • Blowers • Pumps • Hoists • Conveyors • Saw Mill Machinery • Engine Starting.

Keller Tool 1 h.p. Rotary Vane Air Motor.



Keller Tool 70A Axial Piston Air Motor.



We'll gladly send specifications.

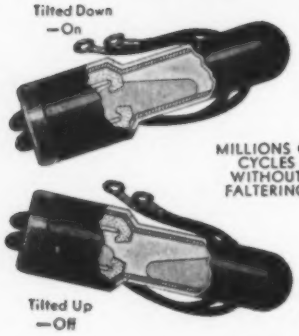
GARDNER-DENVER

THE QUALITY LEADER IN COMPRESSORS, PUMPS, ROCK DRILLS AND AIR TOOLS FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

Circle 610 on page 19

Durakool Tilt Switches are the Life of your Automatic Controls



This steel-clad Durakool mercury tilt switch has unique construction features that deliver years of trouble-free performance on the most difficult assignments you can find. Operating under sealed-in, pressurized hydrogen gas, it takes 24 hours, fast cycling schedules in stride. 7 sizes, 1 to 65 amperes. Send for Bulletin 525.

See telephone directory for local distributor, or write.
DURAKOOL, INC.
ELKHART, INDIANA, U.S.A.---700 WESTON RD., TORONTO 9, CANADA

Durakool ALL-STEEL MERCURY *Switches*

Circle 611 on page 19

ILSCO

THE BIG LUG OF INDUSTRY

For Superior Quality
√ Check these features

- ☐ Pure copper, 100% conductivity
- ☐ Wide wire range—re-usable
- ☐ U/L-CSA Approved
- ☐ Compact—rugged
- ☐ Advanced designing
- ☐ Sound engineering
- ☐ Speedy installation
- ☐ Cool operation—takes overload
- ☐ No special tools needed
- ☐ All screws wax-treated for better clamping

ALL THESE FEATURES AT LOW COST

Your √ Test Will Prove ILSCO Superiority Over Cast Or Any Other Type Lugs

Write for Catalog #50 and Samples

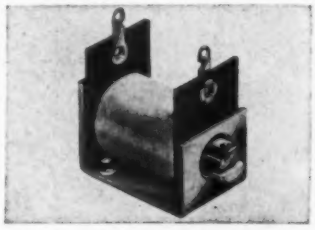
ILSCO CORPORATION

8752 MARIEMONT AVE. **CINCINNATI 27, OHIO**

Circle 612 on page 19

New Parts

ing and vending equipment, solenoid has a stroke of ⅜-in. max. Available in three mounting styles, unit operates on 115 v. Coil of sole-



noid is varnish impregnated for protection under conditions of high humidity. All ferrous parts are cadmium plated to prevent corrosion. **Artisan Electronics Corp.**, Morristown, N. J.

Circle 480 on page 19

Lever Switch

miniature switch has removable lever

Hinged lever switch is designed for ease of removal or assembly of lever, allowing use of standard levers with added secondary operations to meet special application requirements. Operating

force is 10 to 18 *g* and movement differential is 0.020 to 0.080-in. Fully enclosed switch is of simple design and extremely compact. Blade design provides maintained contact and elimination of bounce. Electrical rating is 15 amp, 125 and 250 v ac. **Detroit Controls Corp.**, TyniSwitch Dept., 800 Union Ave., Bridgeport, Conn.

Circle 481 on page 19

Vibration Isolator

may be mounted in any position

Diagonal-spring vibration isolator and shock mounting features all-metal construction for maximum service life and wide operational temperature range. Unit has non-

with *Carpenter* Diamond-Shaped Stainless Tubing

• A new feature in this volume doughnut fryer is the use of super sanitary heating tubes made from diamond-shaped Carpenter Stainless Tubing. The diamond shape permits faster, more economical heating because of the greater heating surface in contact with the fat. Doughnut crumbs cannot settle on the tubes, making cleaning easier and preserving the fat longer.

This is just one more example of combining the inherent advantages of stainless—high strength-weight ratio, fine appearance, corrosion and abrasion resistance and super sanitation—with the extra benefits of special shapes of Carpenter Stainless Tubing. Why not investigate the possibilities of designing and building the advantages of Carpenter Stainless Tubing shapes into your products. Call your nearest Carpenter Distributor or Branch Office for consultation and information.

MEMBER

The Carpenter Steel Company,
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

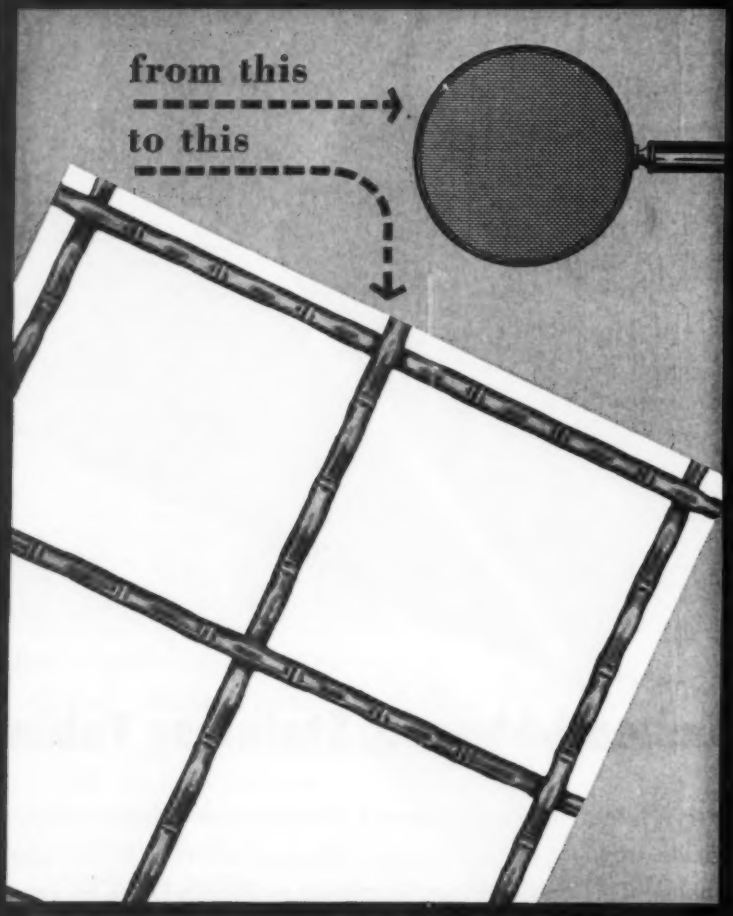
more than corrosion resistance

Stainless Tubing & Pipe

Circle 613 on page 19

Call Cambridge

for prompt service and delivery on INDUSTRIAL WIRE CLOTH with mesh openings



in 9 weaves in any metal or alloy in bulk or fabricated parts

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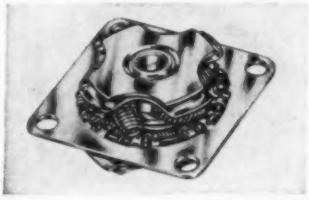
OFFICES IN PRINCIPAL INDUSTRIAL CITIES

New Parts

linear spring characteristics, high damping and all-positional or all-attitude performance. Isolator withstands hours of resonance with input of 0.036-in. double amplitude with equipment mounted



either horizontally or vertically. Low amplification at resonance is approximately twice input. Unit withstands repeated 15 *g* shock without loss of efficiency and 30 *g* ultimate. Unit is available in ¼, ½, 1, 2, and 3 lb load ratings. **United-Carr Fastener Corp.,** Uconite Div., Newtonville 60, Mass.

Circle 482 on page 19

Junction Transistors

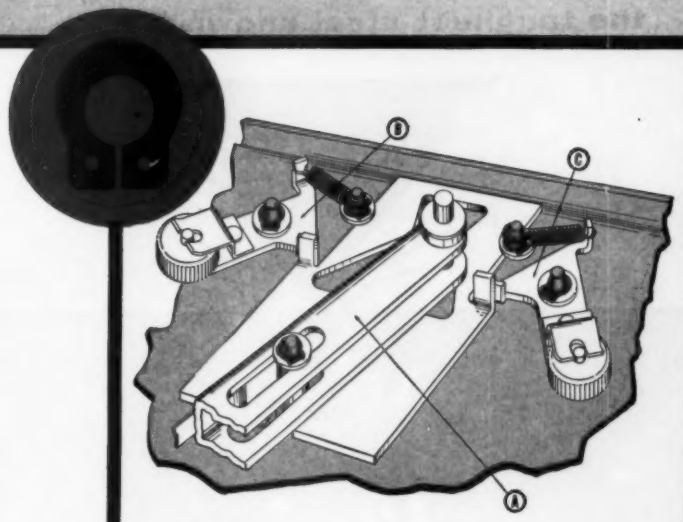
have flexible leads

Three germanium p-m-p alloy type junction transistors have flexible leads which may be soldered or welded into associated circuit. Units are hermetically sealed and employ a metal case with external insulating coating. Type 2N218 is designed for 455 kc, intermediate-frequency amplifier applications and is capable of providing power gain of 30 db at 455 kc in

common-emitter circuits of quantity-produced receivers. Type 2N219 has controlled characteristics for converter and mixer-oscillator applications in standard broadcast band and has conversion power of 30 db at center of band when used in common-emitter circuits. Type 2N220 is low-noise unit for use in preamplifier or input stages of transistorized audio

Waldes Truarc grip rings used on die-cast studs eliminate threading, tapping, other costly machining

Mark Simpson Manufacturing Co., Long Island City, N. Y., uses Waldes Truarc series 5555 Grip Rings to secure parts to studs of the zinc die-cast base of its "Masco 500" portable tape recorder.
The rings—which need no grooves—replace nuts, screws, cotter pins and other types of fastening devices which require threading, tapping, drilling and other expensive machining operations. Because a single cracked or broken stud would render the entire cast base useless—and with it, all assembly completed to that point—the rings also eliminate extremely costly rejects.



Pivot Assembly of shift lever (A) is secured by a single Waldes Truarc Grip Ring and washer. Because the washer must be installed over the shift level in a sliding fit, critical tolerances would have to be maintained if a screw or cotter pin were used. The Truarc Grip Ring eliminates that problem: it requires no groove and may be seated over the washer at any point on the stud, automatically compensating for accumulated tolerances in the parts. BRAKE ASSEMBLIES (B and C) use Grip Rings to secure the brake wheel and spring subassemblies. Here again problems of critical tolerances are avoided and expensive rejects eliminated.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!

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Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
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MD 128

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

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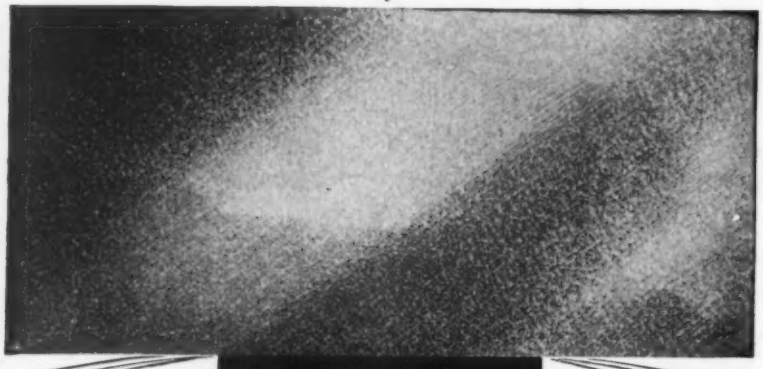
MANGANESE STEEL

the toughest steel known for...

IMPACT



ABRASION

Amsco Manganese Steel actually *absorbs impact energy*. Impact work-hardens the steel's surface to as high as 550 BHN, while retaining high *ductility* beneath the hardened surface. This is a tough steel with the superior ability to *resist abrasion*. The more it is used, the harder and more polished the surface becomes. These are the characteristics of manganese steel that minimize wear and reduce the need for frequent lubrication.

The slow *crack propagation* rate of the steel allows for an *early discovery* of impending failure, even at arctic temperatures.

For a *complete technical discussion* of this high-strength "toughest steel known," write for *your* free copy of booklet, *Austenitic Manganese Steel*, Amsco Division, Chicago Heights, Illinois.

AMERICAN Brake Shoe COMPANY

AMSCO

American Manganese Steel Division

Chicago Heights, Ill.

Circle 616 on page 19

New Parts

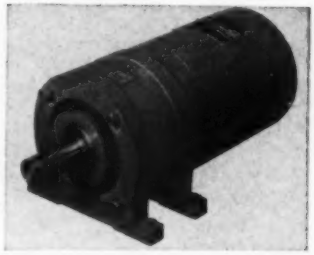
amplifiers operating from extremely small input signals. **Radio Corp. of America,** Semiconductor Div., Somerville, N. J.

Circle 483 on page 19

Gear Assembly

provides ratios to 20,000:1

Compact in-line gear unit has high gear ratios and is suitable for connection to any make of standard flange-type motor without adaption changes. Range of ratios can be provided up to 266:1



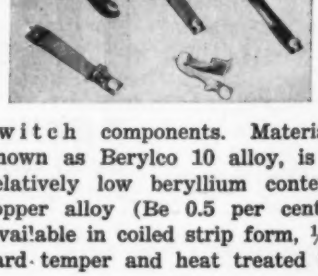
in a single gear stage and up to 20,000:1 in two stages. Unit is furnished as a horizontal or vertical unit with output shaft pointing up or down. Present size range has capacities to 3000 lb-in. Unit has input and output shafts in line with the motor to provide compact assembly. **Odin Corp.,** Castleton, Indiana.

Circle 484 on page 19

Copper Alloy

has high resilience for spring uses

Beryllium copper alloy has high fatigue strength, good resilience for spring uses and good electrical conductivity for parts such as



switch components. Material, known as Berylco 10 alloy, is a relatively low beryllium content copper alloy (Be 0.5 per cent). Available in coiled strip form, ½-hard temper and heat treated to

Circle 617 on page 19→

DOW CORNING CORPORATION

Silicone News

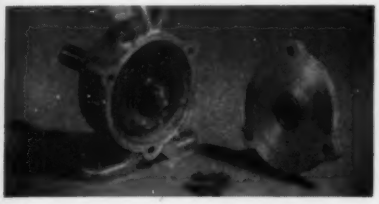
FOR DESIGN ENGINEERS No. 33

Pump Life Tripled with Silicone Lubricant for Plastic and Rubber

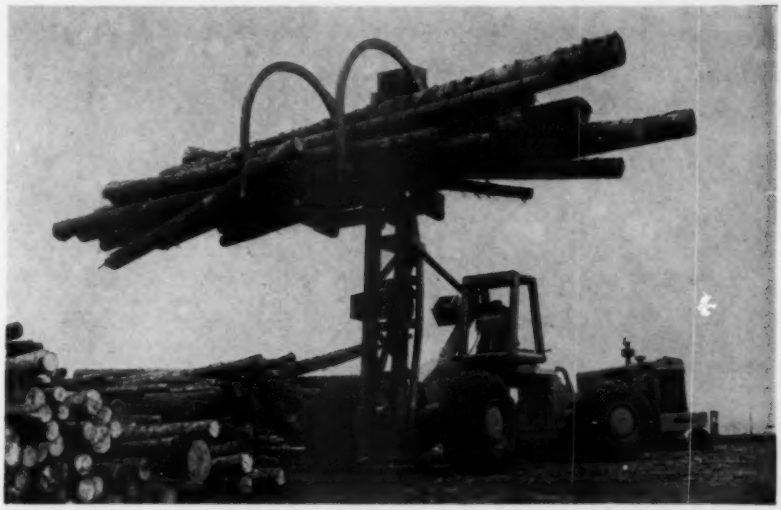
Chemically inert Dow Corning 3 Compound provides outstanding lubrication for moving plastic or rubber parts. Proof of its efficiency is provided by the Becher Pump Company, Chicago, Illinois.

Becher produces a positive-flow chemical pump incorporating a nylon planetary roller plus a vinyl guard and tube. The pump is designed to carry chemical slurries, liquids or gases without danger of contamination or reaction.

By sealing the pump with Dow Corning 3, thus lubricating both plastic parts and sleeve bearing, Becher engineers tripled the unit's service life while reducing power requirements by 50%. They further report



that introduction of the silicone compound so drastically reduced starting torque that they now employ a 1/25 hp, 1720 rpm shaded pole motor to do the work that previously required a more costly 1/12 hp split phase motor. *(Cont. Pg. 2)*



GIANT LOG STACKER ATTAINS GARGANTUAN POWER WITH SILICONE INSULATED MOTORS

Engineers designing large electrically powered equipment are attaining more power per pound while gaining the many advantages of placing the power unit closer to the work by using motors insulated with Dow Corning Silicones. An excellent example is the giant Electric Log Stacker produced by R. G. LeTourneau, Inc., Longview, Texas.

A separate high torque, a/c motor connects directly to every point of load — lift fork, hold-down tusks, boom tilt and rear axle steering. And there is a separate d/c motor inside each of the four rubber-tired drive wheels. A diesel-generator set supplies power to any or all motors on demand.

The work potential of these mechanical giants is worthy of Paul Bunyan. A single bite of the lift forks conveys up to 25 tons of logs; one stacker can move more logs

(Cont. Pg. 2)

Coil Bobbins of Silastic Resist Unusually High Voltage, Temperature

Combine high temperatures and high voltage and you'll quickly expose any weak link in an electrical insulation system. That's what happened when technicians at Transformer Engineers, Pasadena, California, tested conventional choke coils intended for use on aircraft fire control apparatus.

The tests revealed that conventional coil bobbins all too often developed "electrical punctures" in the tube-to-flange joints when subjected to 15,000 volts at 140 C (320 F) operating temperatures.

The problem was overcome, however, with bobbins molded in one piece of Silastic, the Dow Corning silicone rubber. Featuring excellent thermal stability and dielectric strength after prolonged exposure to high temperatures, their one-piece construction avoided tube-to-flange joints entirely Over 3000 of them have been put into service in the last two years; not one failure has been reported to date. *No. 329*

CLASS H MOTOR STILL ON TEST AFTER 60,039 HOURS AT 240 C

At 10 A.M., June 6, 1946, a Class H insulated 10 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since it has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A. M. October 1, 1956, this motor was still on test after 60,039 hours at an average copper temperature of 240 C! That's equivalent to 367 years operation at the Class H temperature of 180 C.

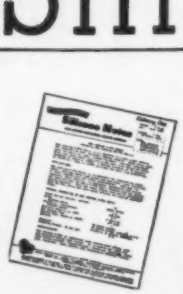
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Parts fabricated of Silastic are now available from over 150 companies listed in recently revised reference. Conveniently located in or near most industrial areas, these companies are equipped to fabricate Silastic parts to meet every requirement, including coated fabric, ducting and hose, extrusions, gaskets and seals, molded parts, O-rings, rollers, specialty and sponged parts, wire and cable. *No. 334*

Documentary film "What's a Silicone?" available free of charge for showing to technical audiences. For more information circle *No. 335*

Primers and Adhesives for Silastic are listed in a compact reference sheet that compares methods of application and recommended cure times, all in easy-to-read tabular form. A handy and valuable aid to designers and engineers in selecting the product best suited for a particular application. *No. 336*

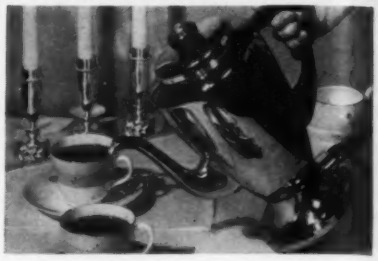
"Silicone Insulated Conductors," a reprint from WIRE AND WIRE PRODUCTS, describes and compares eight different types of silicone insulated wire and cable currently available for different applications. *No. 337*

Dow Corning Silicone Lubricants, including oils and greases, are described in a new, illustrated 8-page brochure that gives their properties, lists typical applications, and cites factors which contribute to obtaining longer life. *No. 338*

All New — 1957 Guide to Dow Corning Silicones is a twelve page, fact-filled catalog which briefly describes the silicone products of interest to most industries. Containing latest data and information, the guide is designed expressly to help you enjoy the advantages, profits, and savings made possible through imaginative use of these unique engineering materials. *No. 339*

Improve Percolator With Silicone Laminate At No Extra Cost

Designers who make imaginative use of silicones to increase the life and reliability of toasters, steam irons, and other appliances can often do so without adding a single penny to the cost of the finished product. A recent example is provided by Aluminum Goods Manufacturing Company, manufacturer of Mirro-Matic Percolators.



While Mirro-Matic's terminal pin insulators made of phenolic had proven satisfactory in normal use, the designers reasoned that abuse of the percolator could loosen electrical connectors and cause arcing. Phenolic is also prone to absorb moisture when splashed or dunked by careless users, raising a further possibility of insulator failure.

The risk of such breakdown, however, was entirely eliminated by the superior dielectric strength, heat and moisture resistance of silicone-glass laminates manufactured by Taylor Fiber Company. The moisture absorption of silicone laminate, for example, is only 0.02% compared with about 2% for phenolic.

And, because of the higher physical strength of silicone laminate, plain low cost stampings could be used instead of expensive molded parts. And they produced a further saving by reducing breakage during assembly.

The score: greater reliability for the Mirro-Matic Percolator without adding a cent to production costs! *No. 330*

LOG STACKER *(Continued)*

in 5 minutes than three conventional yard lifts can handle in 30 minutes!

To provide maximum power and reliability every working motor — like all drive motors on all LeTourneau "electric wheel" equipment — is Class H insulated with Dow Corning Silicones. *No. 331*

TRIPLE PUMP LIFE *(Continued)*

Dow Corning 3 Compound dissipates heat so effectively the pump remains cool even when pumping dry. No decrease in capacity or pressure has been noted after 3000 hours' operation at 1750 rpm. *No. 332*

SILICONE DAMPING FLUID KEEPS ACCELEROMETER ON THE "ALERT"

Because Dow Corning Silicone fluids show little or no change in damping force over a wide temperature span, many engineers are utilizing them to produce performance features and economies not possible with organic damping oils. Here's how M. Ten Bosch, Inc., Pleasantville, N. Y. did it:

Capitalizing on the inherent physical and chemical stability of Dow Corning 200 Fluid, Ten Bosch has designed an accelerometer weighing a mere 2½ ounces that retains a sensitivity of plus or minus .006 G at up to 6 Gravities. The time constant of the unit is only .0002, yet it has absolutely no undamped natural frequency.

Dow Corning 200 Fluid was selected as the "integrating fluid" for this unit after tests on dozens of other materials including motor oil, kerosene, mineral oil, water and air failed to meet Ten Bosch's requirements. Non-corrosive, non-conducting and non-gumming, the 200 Fluid permits the accelerometer to retain all of its original alertness and sensitivity over a wide temperature span in aircraft, missiles, and gyroscope direction service. *No. 333*

Dow Corning Corporation, Dept. 6812, Midland, Michigan

Please send me: 329 330 331 332 333 334 335 336 337 338 339

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE___ STATE_____

SILICONE NEWS is published for product design and development engineers by

DOW CORNING MIDLAND — *first in silicones* — DOW CORNING SILICONES — CORPORATION MICHIGAN

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CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

New Parts

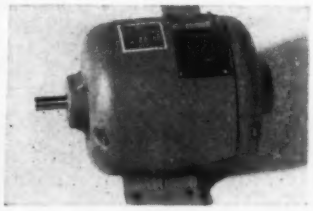
provide good electrical and mechanical properties, material withstands severe forming operations and stands up under repeated flexing in use. Tensile strength is 110,000 psi min; elongation in 2 in. is 5 per cent min; and electrical conductivity is 48 per cent IACS min. **Beryllium Corp.**, Reading, Pa.

Circle 485 on page 19

Torque-Brake Unit

provides torque range from 3.33 to 0.77 in.-lb

Three compact torque-brake units give a wide range of speed-torque characteristics and are designed to provide continuous tension. Torque can be decreased by reducing the applied voltage or increased if intermittent ratings are permissible in the application. Three units provide torque at 2000 rpm of 3.33, 1.80 and 0.77 in.-lb. **B. A. Wesche Electric Co.**, 1622 Vine St., Cincinnati 10, Ohio.

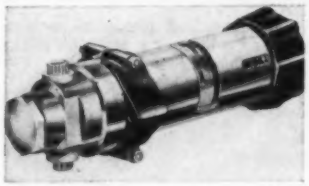


Circle 486 on page 19

Pressure Regulator

provides accurate pressure from 0 to 5000 psi

High-flow regulator has wide range with normal inlet pressure of 6000 psi. Unit maintains accurately regulated pressure from 0 to 5000 psi. Burst maximum is 15,000 psi; maximum handle torque is 30 in.-lb; and unit is adaptable for use with air, nitrogen, helium, or gaseous oxygen. Unit is available in ¼-in. tube straight-thread gasket



(*Continued on Page* 194)

something NEW!

a BETTER air valve

PATENT PENDING

. . . the SA series

NEW SIMPLICITY . . . a lapped spool sliding in a hardened sleeve provides the valving action—*One moving part.*

NEW RELIABILITY . . . the valve has no moving seals; eliminates wear, sticking, swelling of elastic seals. Gives positive, trouble-free performance.

NEW RUGGEDNESS . . . the SA Series sets new standards for long life. Outwears ordinary valves on every test.

NEW DESIGN . . . full sub-plate mounting, watertight solenoid enclosures, integral junction boxes on all double solenoid models, side ports, bottom ports, O-ring manifold mount . . . all are standard on the SA Series.

The SA Series offers a complete line of actions, single solenoid spring return, double solenoid momentary contact and double solenoid spring centered 4-way actions . . . single and dual pressure versions. 54 different models in sizes ¼" through ¾" pipe. The most complete family of 4-way air valves available.

Get complete information and specifications by mailing the coupon.

NUMATICS, Inc. MILFORD, MICHIGAN

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Dept. MD
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Milford, Michigan

Send me your catalog No. 8000 on the new SA Series Valves.

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COMPANY_____

ADDRESS_____

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How to Control Corrosion on Bare Aluminum

Corrosion is a real threat to aluminum, especially to the higher strength alloys. It can be controlled by using a chemical surface treatment, with results as dramatically effective as those shown in the illustrations at the right.

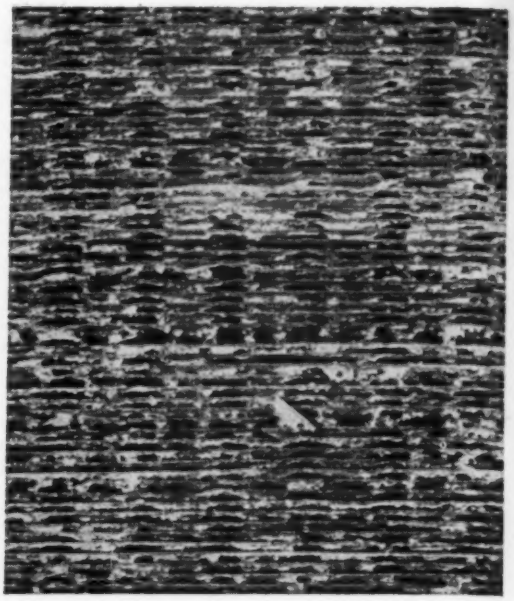
The corrosion protection is effected by Bonderite 710 or 720, applied by spray, immersion, or brush-on methods. A thin, iridescent coating, light to golden brown depending on the alloy treated, covers all surfaces of the aluminum and protects it against corrosion.

The coating produced by Bonderite is integral with the metal itself. It is flexible and can withstand moderate draws without difficulty. Arc and spot welding fabrication methods need not be changed, because the coating conducts electricity. It has good resistance to bimetallic and galvanic corrosion. Sheets, castings, forgings, extruded and rolled structural forms may be treated.

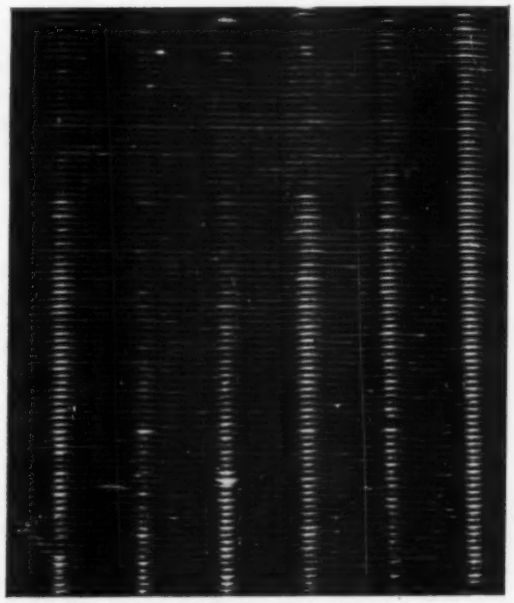
Bonderite 710 and 720 solutions are sludgeless, easily controlled, uniform in results.

These treatments may be used to increase the durability of paint finishes with equally outstanding effectiveness.

The Parker man in your territory has valuable experience to share with you in treating aluminum and its alloys. A letter or phone call will bring him to you.



UNTREATED—Unretouched photo of section of aluminum heat exchanger after 1150 hours in salt spray. Note corrosion.



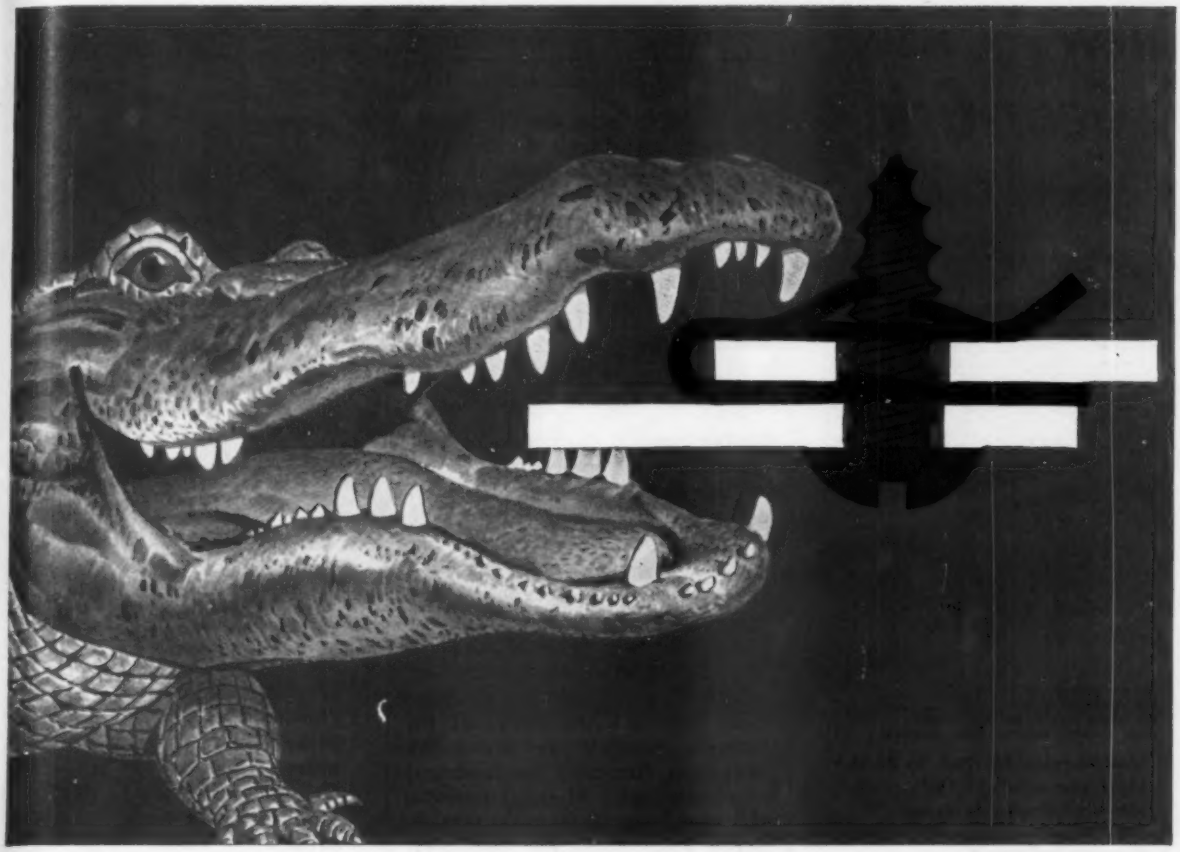
BONDERITE-TREATED—Unretouched photo of section of identical aluminum heat exchanger after 1150 hours in salt spray. Note absence of corrosion.

SINCE 1914—LEADER IN THE FIELD

PROTECTED BY Bonderite PARKER RUST PROOF COMPANY QUALITY CORROSION RESISTANT

PARKER RUST PROOF COMPANY
2193 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883



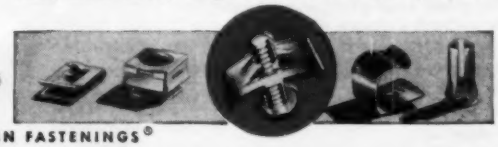
STEEL JAWS THAT NEVER RELAX
fasten a fastener in place

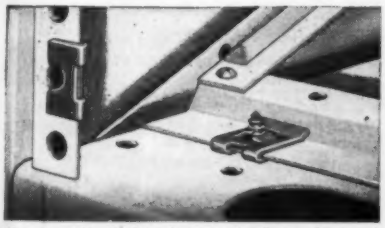
Alligator jaws have nothing on Tinnerman "U" and "J" type fasteners in gripping power. These fasteners press easily into locked-on position over panel edge or center panel locations. Yet they provide positive self-retention, ending the need for welding, staking or other secondary fastening devices. They are ideally suited for blind assembly or hard-to-reach locations.

When combined with the familiar Tinnerman SPEED NUT, this unique fastening principle provides a one-piece, self-locking, self-retaining fastener that is fast and easy to apply. The "U" or "J" feature can be combined with wire and tube retainers, latches, catches and a host of other fastening requirements to save time, material and production costs.

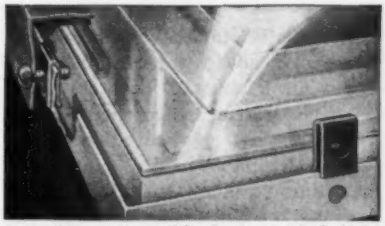
Find out about these and more than 8,000 other types of SPEED NUT brand fasteners now serving industry all around the world. They can make important savings for you, can also simplify your assemblies. See your Tinnerman representative soon or write to us. **Tinnerman Products, Inc., Box 6688, Dept. 12, Cleveland 1, Ohio.**

TINNERMAN
Speed Nuts®
FASTEST THING IN FASTENINGS®

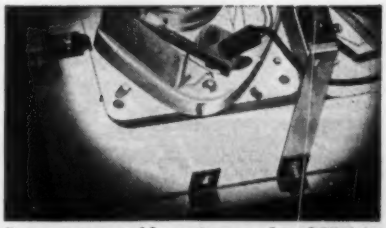




Greater flexibility for control equipment enclosures is provided by self-retaining "J" type SPEED NUTS at 30% less production cost.



Assembly costs on this sheet-metal skylight frame are reduced 66% by Tinnerman "U" type SPEED NUTS.



Gas range assembly costs are reduced 25% to 50% by using Tinnerman "U" and "J" type SPEED NUTS.

NEW . . . NEW!

Gear-Grip

Flexible Coupling

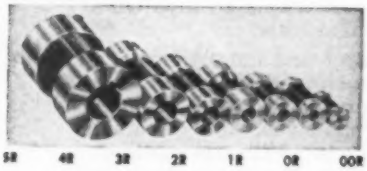
The most revolutionary design advancement for integral H.P. in a century!

Positive power transmission of rated load. Gear teeth on end casting match special rubber tube section.

- Load ranges—2½ H.P. to 25 H.P.
- Shaft sizes—¾" to 1⅞".
- Specified lengths to design requirements.
- Prevents end thrust.
- "By Eye" shaft alignment.
- No lubrication required.
- Shaft Safety features.

Dyna-Line . . .

The finest flexible coupling in single unit construction—specifically designed for fractional H.P.



5R 4R 3R 2R 1R 0R 00R

- True Flexibility and Torsional Resilience for quiet, load-plus power transmission without extreme deflection or twist.
- Lengths varied to design specifications in each series.
- Load ranges—1/15 to 1½ H.P.
- Shaft sizes — 3/16" to ¾".
- Lowest O.D. for highest torque capacity.

Write for Catalogs and Technical Bulletins.

Guardian PRODUCTS CORP.
COUPLING DIVISION

DEPT. M-126, 1215 E. SECOND ST.
MICHIGAN CITY, INDIANA

Circle 621 on page 19

New Parts

(Continued from Page 191)

seal or ¼-in. pipe thread. Internal valve and filter are removable without disturbing spring or diaphragm structure. **Accessory Products Corp.**, Dept. MD, 616 W. Whittier Blvd., Whittier, Calif.

Circle 487 on page 19

Baking Enamel

one-coat material has high toughness

Baking enamel coating looks and performs like porcelain. Known as Duracron, enamel is based on new series of thermosetting acrylic resins. It is adapted to finishing of heavy appliances and industrial products requiring toughness, mar resistance and durability. Comparative tests with alkyd-melamine enamels showed improvement in color and gloss retention on overbake, chemical and detergent resistance, humidity and salt-spray resistance, flexibility, hardness and mar resistance. Material provides full protection in one coat. **Pittsburgh Plate Glass Co.**, Industrial Finishes Sales Div., 632 Fort Duquesne Blvd., Pittsburgh 22, Pa.

Circle 488 on page 19

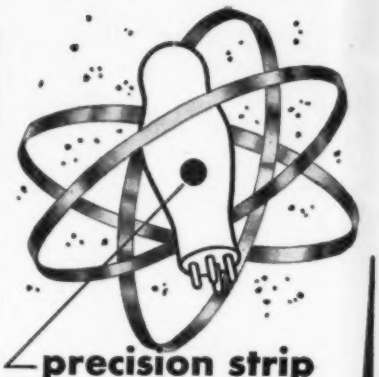
Cartridge Heater

delivers up to 200 watts per sq in.

Electric cartridge heater for applications where temperature requirements are high and space is limited delivers as much heat as conventional heater five times its

size. Fully insulated resistance wire is close to sheath, allowing rapid dissipation of heat through sheath. Ratings are 40 to 200 w per sq in. of heated surface. Unit is available in ⅜, ½ and ⅝-in. diam and in 1¼ to 10 in. sheath lengths. **Vulcan Electric Co.**, 85 Holten St., Danvers, Mass.

Circle 489 on page 19



precision strip for electronics applications

From 0.0005 in. to 0.040 in. thick and 0.090 to 6 in. wide, these alloys are available as special-tolerance strip:

Beryllium Copper
Phosphor Bronze
Nickel Silver
Brass
Chromium Copper
Stainless 17-7PH
Invar
Magnetic: High Nickel

Some immediately available. Others rolled to order in 2 to 21 days. Can be supplied in coils or straight lengths with slit or filed edges—also cadmium plated.

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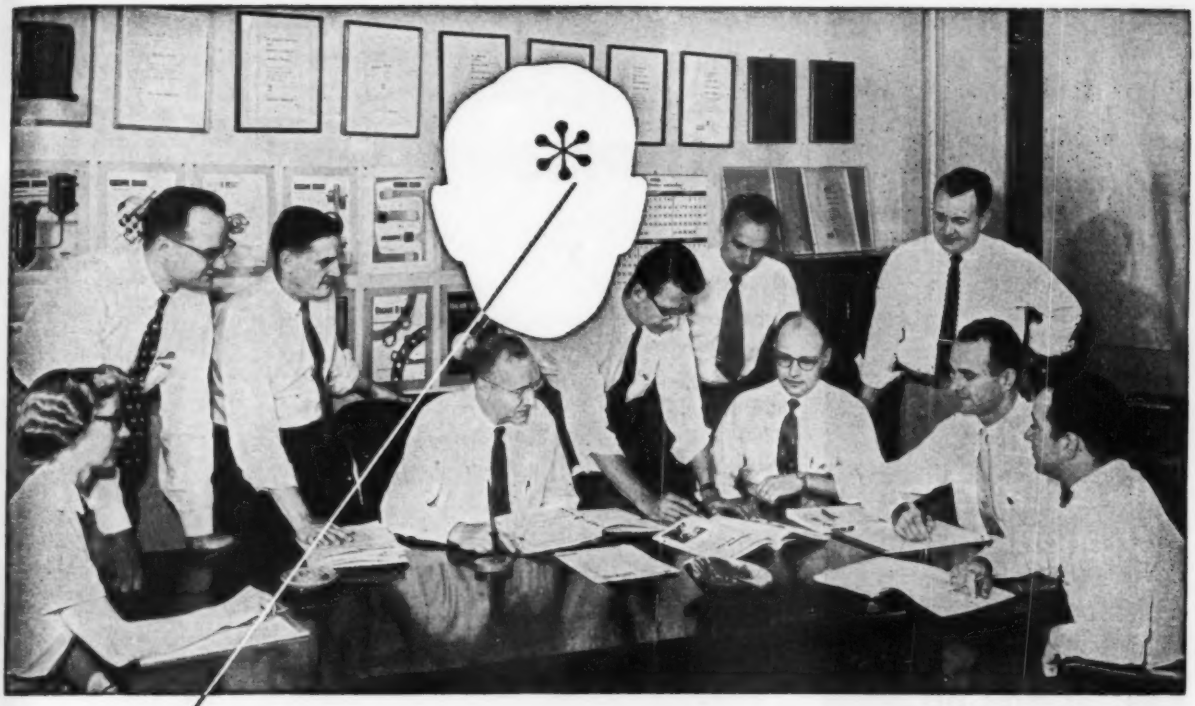
New York — BERYLLIUM COPPER SUPPLY CO., Little Falls, New Jersey
Chicago — PRECISION STEEL WAREHOUSE INC.
Los Angeles — KRUSEN WIRE & STEEL CO.

Circle 622 on page 19



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Technical Editor Wanted

• Here is your chance to gain a broad knowledge of the design engineering field and related activities.

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• Additionally he will be encouraged to progress as a specialist in one or more of the branches of design engineering.

• He should have had some design experience, and an EE or ME degree would be desirable.

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• Headquarters are in Cleveland, with opportunities for travel to attend meetings and expositions and to seek material for publication.

• If you are interested and feel qualified, send full details of your engineering and writing experience to the Editor, MACHINE DESIGN, Penton Building, Cleveland 13, Ohio.

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Have twice the rigidty... three times the strength

Yet require less material ...cost less to fabricate

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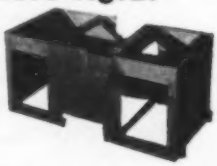
40% more rigid!

. . . yet this machine base of welded steel costs half as much as former cast iron designs.



Ask

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio

The World's Largest Manufacturer of Arc Welding Equipment

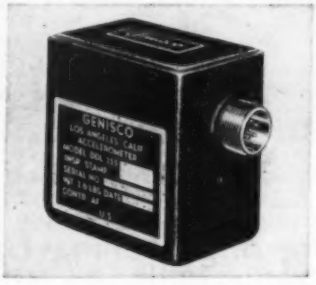
Circle 624 on page 19

ENGINEERING DEPARTMENT
EQUIPMENT

Accelerometer

has extreme resistance to vibration and shock

Potentiometer-type accelerometer is a dual-damped low-range instrument with good resistance to severe vibration (withstands 10-*g* accelerations from 10 to 1500 cps) and shock accelerations (to 40-*g*



shock of 5 miliseconds duration). Damping, 0.65 of critical at 75 F, is accomplished by use of a permanent magnet and silicon fluid. Range is ±0.1-*g* to ±8 *g*, or up to ±30 *g* with reduced damping. Unit will operate at temperatures from −10 F to + 180 F, and offers linearity within 1 per cent of full scale. **Genisco, Inc.**, 2233 Federal Ave, Los Angeles 64, Calif.

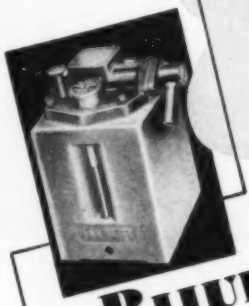
Circle 490 on page 19

Sphere Grid

speeds spherical drawing or measuring

Sphere grid is a drafting underlay presenting an acurate, finely-divided grid of spherical coordinates. Unit combines scale, protractor, solver and ellipse guide, eliminating need for mathematical formulas or constructions. Device allows drawing accurate, measured pictorial spherical diagrams representing problems in solid geometry, gyroscopics, mechanical motion and military problems. Sphere and ellipse problems in engineering drawing and descriptive geometry may be solved without point-by-

YOUR SILENT PARTNER



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HELPS YOU
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• design savings into the equipment you make

Hand oiling is costly! It wastes time and money . . . steals valuable production hours . . . means extra down-time, fire risk, repair bills, replacement parts and causes product damage from excess lubricant.

But there's a way to end all this waste and worry. A Bijur Automatic Lubrication System never forgets a bearing . . . bearings never are thirsty for oil, never flooded. Lubrication is continuous, exactly right. All the hazards of hand oiling are banished—*automatically!*

Bijur Systems are custom-engineered for machinery used by practically all industries. Every bearing receives a clean supply of oil at the right time . . . automatically and correctly metered to suit its individual needs . . . while the machine is running! Whether for new equipment you *buy*, or machines you *build*, insist on Bijur. It's better—*by design!* ® 1939

P-5

BIJUR
LUBRICATING CORPORATION
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Pioneers in Automatic Lubrication

Circle 625 on page 19

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Elevated Temperature Drawing

*a **new** material—made by*

*a **new** process—with*

*a **new** combination of properties*

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Plus Accuracy, Smooth Finish, and Straightness

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Circle 626 on page 19

● Wherever fluid proportioning is used in industry, the Model 1106 Proportioneer Pump is known for its work-horse stamina, its watch-like accuracy. Helping to build this reputation for ruggedness and precision, Winsmith Speed Reducers have been selected for use on these pumps since 1932.

Proportioneers, Inc., a division of B-I-F Industries, rate performance as the main reason for continued selection of Winsmith reducers but in looking beyond the price tag and the performance they pay for — they find a highly important *extra* that's not for sale but given freely at Winsmith — that's *co-operation* in helping customers to solve speed reducer problems.

As Proportioneers, Inc., puts it: *"... co-operation is one of those things that can't be covered by a price tag but it is one of the big reasons why we have stayed so long with Winsmith."*

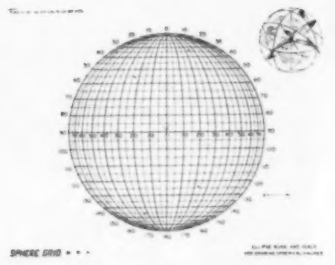
When you select Speed reducers, keep this *extra* in mind. The services of our engineering department are always at your service to help you select the right reducer for every application from 1/100 to 85 h.p.

WINSMITH SPEED REDUCERS

WINSMITH, INC.
16 Elton Street
Springville (Erie County) N. Y.

Engineering Equipment

point plotting or intersection methods. Foreshortening along isometric, dimetric, trimetric and non-isometric axes may be computed



without formulas or box constructions. **Sphere Grid Sales,** 3829 Davis Place N.W., Washington 7, D. C.

Circle 491 on page 19

Microfilm Reader

enlarges and prints copy up to 14 by 14 in.

Microfilm reader makes large prints by direct projection of the film image on photocopying paper. Desk-top unit serves as a viewer and printer for aperture cards or jacket cards. Viewing and printing

screen is 14 by 14 in., making unit suitable for general business operations in which enlargement is required. By use of interchangeable lens, unit will provide magnifications from 15X to 42X. Overall dimensions of unit are 30 in. high with 17 by 17 in. base. **Dexter Folder Co.,** Filmsort Div., 50 S. Pearl St., Pearl River, N. Y.

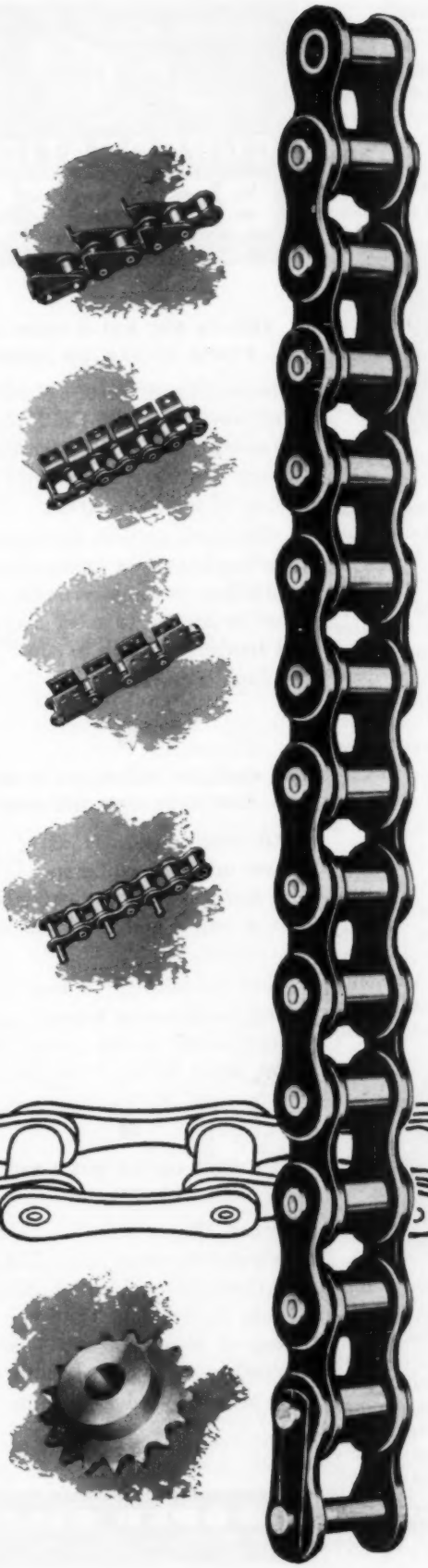
Circle 492 on page 19

Oscillograph

direct-recording unit has high sensitivity

Dynamic recording oscillograph produces instantly-readable records, combining high-frequency and sensitivity characteristics of photographic oscillographs with con-

Circle 627 on page 19



SAVE handling costs

Here's a good way to solve the problem of moving materials, or coordinating actions, on your machine—the complete line of Rex Roller Chains, Sprockets and Standard and Special Attachments. Whether it's moving bread through a wrapping machine...milk cartons through a bottling machine...or metal parts through a plating machine, there is a Rex Roller Chain and Attachment that can do it more efficiently... at lower cost. Your CHAIN Belt District Sales Engineer will be happy to assist you with your selections or to recommend the design of an attachment to suit your individual needs. Call him or mail the coupon today.

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☐ Please send me literature on Conveying with Roller Chains.
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Company.....

Address.....

City.....*Zone*.....*State*.....

Circle 628 on page 19

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MECHANICAL ENGINEERS
MECHANICAL DESIGNERS

---to make
ELECTRONICS
systems work!

Don't think you have to get away from the mechanical field or make a big readjustment in order to build a brighter future *faster* in the expanding Electronics Industry! No sir, you can use your particular training, skill and ability to the fullest; because most electronics systems are mechanical in operation!

•

At Bendix Radio you'll find us acutely aware of your professional status, we have important, challenging work for *you* . . . and the way up the ladder of success is *faster*. That's because Bendix Radio is a respected leader in the development and production of the world's finest military and commercial electronics systems.

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BR **Bendix**
DIVISION OF BENDIX AVIATION CORP.
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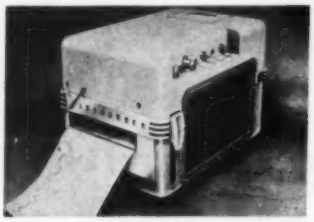
Radio

Circle 629 on page 19

Engineering Equipment

venience of direct-writing instrument. No powder magazines or other processing material is required. Flat frequency response of 200 cps is achieved without peaked amplifiers or other compensation. Unit accommodates up to six chan-



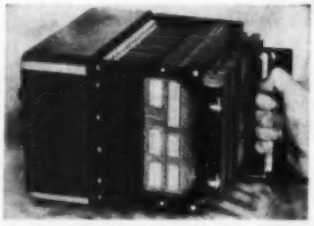
nels; each with full 6 in. deflection, and traces may overlap. Chart speeds are 0.2, 1, 5 and 25 in. per second, minute, or hour. Instrument accommodates 100 ft of record, may be loaded in daylight, and has indicator showing amount of unused record. Unit operates on 115 v, 60 cycle. **Minneapolis-Honeywell Regulator Co.**, Heiland Div., 5200 E. Evans Ave., Denver 22, Colo.

Circle 493 on page 19

Arithmetic Control

digital unit has plug-in circuit cards

Computing unit operates on 3 v potential and employs direct-coupled circuitry, thereby eliminating many components normally required. Unit contains nearly 1000 transistors, 300 resistors, and



12 capacitors permanently dip-soldered into compact, plug-in, printed-circuit cards. Each card provides all necessary functions for one binary digit including add, subtract, multiply, divide, square root, shift right, shift left, sign magnitude and absolute magnitude. Ten "math" cards and seven "control" cards are plugged into 10 in. long unit. Instrument adds two numbers in 1.5 mu sec and

COOPER ALLOY
CORPORATION BRIEFS

TEFLON AND KEL-F INCREASE RANGE OF VANTON PUMPS

The recent addition of a Kel-F liner and now a Teflon or Kel-F housing to existing materials of the Vanton pump has increased greatly their range of corrosive service.

Designed without shaft seals or stuffing boxes, the pump furnished with these new materials has excellent resistance to most corrosives at temperatures up to 300°F.

Details on request.

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*Advanced Know-How of technique makes the difference in casting stainless steel defibering blades for a paper and pulp machinery manufacturer.

For the full story of how Cooper Alloy Shellcasting knowledge may mean higher quality castings for you, write for Bulletin AKH#5.

PLUG COCKS WITH V2B CUT GALLING

Cooper Alloy's V2B keys used in their stainless steel plug cocks have cut down the problem of galling to a very great extent. The September issue of Newscast tells how this helped a tank car manufacturer out of an expensive problem.

COOPER ALLOY
CORPORATION • HILLSIDE, N.J.

Circle 630 on page 19

Why close tolerances in resilient gaskets are rarely necessary

Tolerances in the size and shape of a gasket do not become critical if the material chosen seals effectively over a wide range of compressions.

Armstrong Cork-and-Rubber Compounds are typical of such wide range materials. They seal tightly under compressions ranging from 20% to 33%. As a result, tolerances in the size of the gasket can be as wide as ±.010". In some applications, the wider tolerances permissible with compressible gasket materials may effect savings in machining time.

Confined applications

Cork-and-rubber's wide compression range—and the resultant wide tolerances possible—is particularly valuable in confined gasket applications. Because these materials are truly compressible, they decrease in volume under load. This enables cork-and-rubber gaskets made slightly oversize to compress into a completely confined space. The absence of side flow makes it easy to mate flanges perfectly.

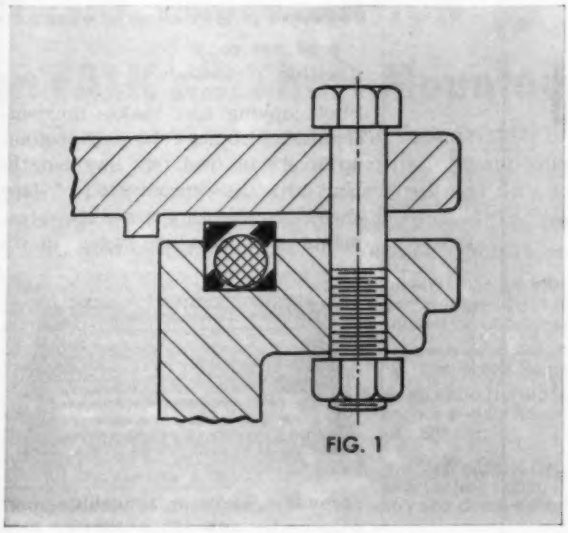

FIG. 1

Figure 1, for example, illustrates the relative sizes of a cork-and-rubber gasket and a comparable non-compressible molded ring. The resilient cork-and-rubber compound permits wide tolerance in its size, whereas the molded ring must be made to very close tolerances to allow perfect fit between the flanges.

Similarly, in figure 2, wide tolerance cork-and-rubber gaskets make an effective packing ring. Their true compressibility controls lateral flow and prevents excessive build-up of radial pressure on the shaft.

Metal-to-metal joints

When non-compressible rings were used on the flanged journal of the calender roll shown in figure 3, extremely close tolerances were required. Undersized rings leaked. Oversized rings prevented metal-to-metal contact between the flanges and caused misalignment. Both of these problems were solved with the use of standard tolerance cork-and-rubber rings, which fitted perfectly and sealed tightly.

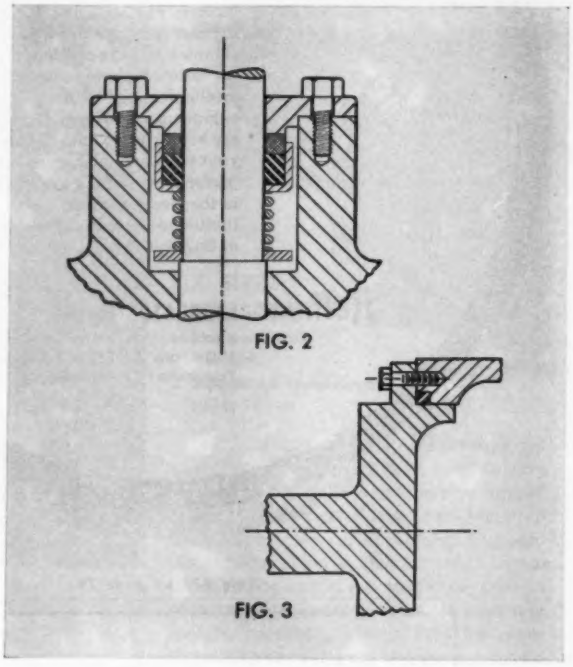

FIG. 2

FIG. 3

We recommend that you discuss specific sealing problems with an Armstrong representative. Methods and materials he may suggest may help you reduce production time and lower costs.

SEND FOR 24-PAGE GASKET MANUAL

You'll find other useful information on the design and use of gaskets in the new Armstrong Gasket Design Manual. Write for your copy of this manual to Armstrong Cork Co., Industrial Division, 7112 Dean Street, Lancaster, Pa.

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Circle 632 on page 19

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"Adjustable-Speed Drives"

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Engineering Equipment

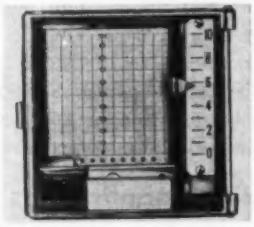
multiplies in 15 mu sec. Units with larger digital capacitities may be constructed by increasing number of plug-in cards. **Philco Corp.**, 4700 Wissahickon Ave., Philadelphia, Pa.

Circle 494 on page 19

Recording Potentiometer

with either ac bridge or potentiometer circuitry

Miniature self-balancing electronic recording potentiometer gives a continuous record on a 3 in. strip-chart. Available in either poten-



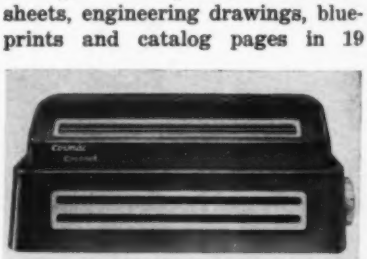
tiometer or ac bridge models, instrument can be used to measure and indicate or record any variable which can be converted into an electrical quantity. **Bristol Co.**, Waterbury 20, Conn.

Circle 495 on page 19

Photocopying Unit

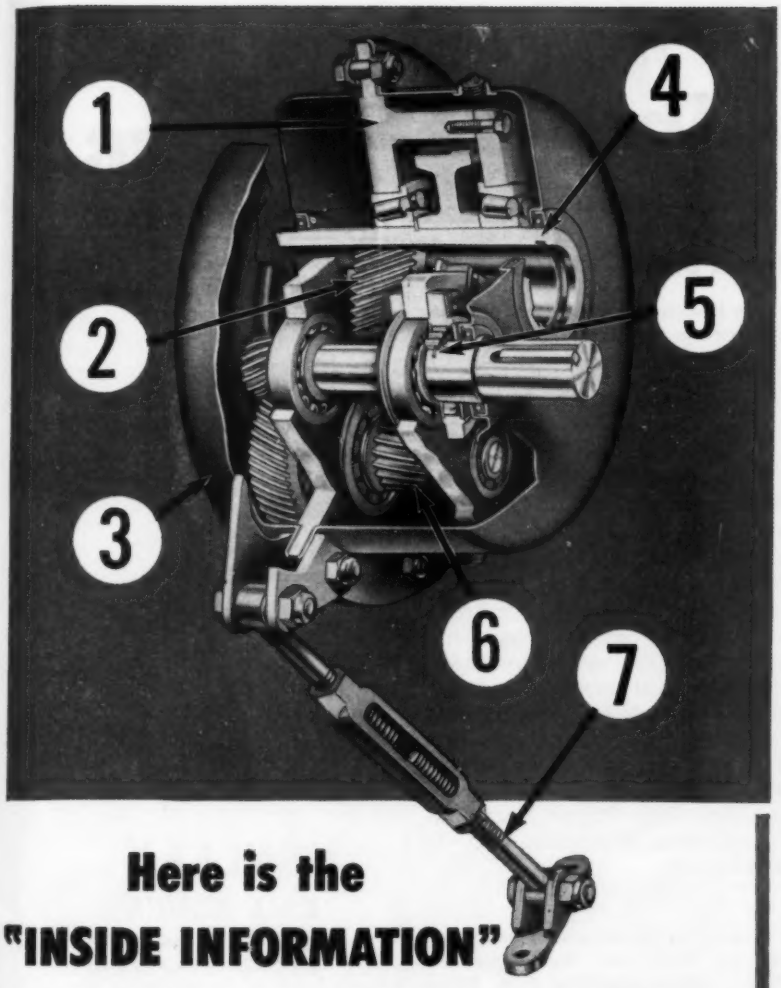
produces copy within 19 seconds

Photocopying unit makes inexpensive, exact copies from any original up to 18 in. wide by any length. Unit provides reproduction of data sheets, engineering drawings, blueprints and catalog pages in 19



seconds. Single-unit machine operates under any office lighting conditions, from subdued incandescent to full daylight. Housing is soil-proof, corrosionproof acrylic plastic; total weight is 29 lb. **Cormac Industries Inc.**, 80 Fifth Ave., New York, N. Y.

Circle 496 on page 19



Here is the "INSIDE INFORMATION" on FALK ALL-STEEL Shaft Mounted Drives

Take a careful look inside the Falk all-steel Shaft Mounted Drive, and you will know why this newest member of the famous Falk family is ideal for applications where direct mounting on the driven shaft is desirable. It is the only drive in its field with all these superior "In-built" factors:—

1 **All-steel Frame,** with more than double the rigidity of iron, supports all rotating elements.

2 **Precision Helical Gears,** designed and machined by Falk, rated to AGMA standards.

3 **Pressed Steel Housings,** whose sole function is to keep oil in, dirt out; easily removed for gear inspection without dismounting unit.

4 **Through Hollow Shaft** with counter bore provides for easiest installation or removal from driven machine shaft extensions.

5 **Backstop** can be furnished with the unit or added later for positive prevention of reverse rotation.

6 **Positive Lubrication,** continuous direct dip of revolving elements at all speeds.

7 **Tie Rod** and turnbuckle serve as anchor and facilitate V-belt or chain adjustment.

Write to Department 247 for engineering bulletin, including selection and dimension details.

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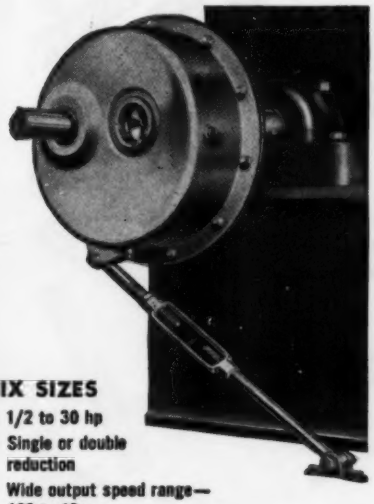

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- 1/2 to 30 hp
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- Wide output speed range—420 to 10 rpm

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A FEW TYPICAL APPLICATIONS

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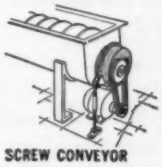
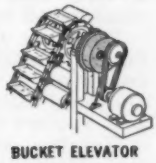

SCREW CONVEYOR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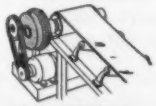
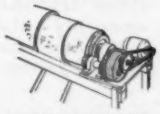

BELT CONVEYOR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Circle 633 on page 19

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Circle 634 on page 19

THE ENGINEER'S Library

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Recent Books

The Design and Conduct of Human Engineering Studies. *By Alphonse Chapanis, professor of psychology and industrial engineering, John Hopkins University; 73 pages, 8½ by 11 in., paperbound; published by and available from San Diego State College Foundation, San Diego 15, Calif., $2.00 per copy.*

This booklet presents the results of studies in this relatively new field. Subjects covered include methods of observation, methods for study of accidents and near accidents, experimental methods, psychophysical methods and statistical methods with summarizing, interpreting and experimental data. The book concludes with a discussion of some special problems of experimenting with people, including selection of subjects, methods, and apparatus.

Contracts, Specifications and Engineering Relations. *By Daniel W. Mead; 427 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36; available from* MACHINE DESIGN, *$7.00 postpaid.*

This book discusses legalistic relations for the engineer. Among the subjects covered are ethics, law, contracts, specifications, and the writing of technical reports and business letters. The specifications section is based on actual specifications currently in use. The chapters dealing with legal matters cover general relations, rights and responsibilities of engineers.

Application of Strip Springs to Instrument Design. *24 pages, 6 by 9½ in., paperbound, side-stapled; published by and available from Department of Scientific and Industrial Research, Charles House, 5-11 Regent St., London S. W. 1; 36c per copy.*

This booklet provides designers with information concerning appli-

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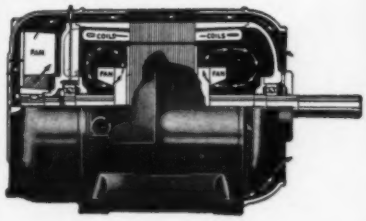

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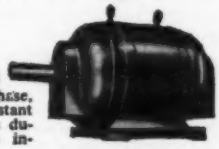

Other Types of Valley Motors

Type SN polyphase, high torque, constant speed, continuous duty, squirrel cage induction.

Type AN single phase, constant speed, continuous duty, repulsion start, induction run.

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Circle 635 on page 19

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cations of strip springs for instrument and other light-duty purposes. Discussed are the functional principles, suggested applications, and mathematical and design data.

Aerodynamics, Propulsion, Structures and Design Practice. *Edited by Grayson Merrill, Captain, USN, navy technical director, Jupiter Ballistic Missile Project, Bureau of Ordnance; 595 pages, 6 by 9 in., clothbound; published by D. Van Nostrand Co. Inc., 120 Alexander St., Princeton, N. J.; available from* MACHINE DESIGN, *$10.00 postpaid.*

This second volume in the series of Principles of Guided Missile Design is divided into three sections. The aerodynamics section presents problems of guided missiles, nature of air flowing supersonically over bodies and control surfaces, rocket and air-breathing engines, and aerodynamic characteristics of various airframe configurations. The section on structures and design practice covers design of the airframe and packaging of its contents, design criteria, environmental loads, materials and fabrication methods.

Association Publications

Criteria for Professional Employment of Engineers. *23 pages, 5½ by 8½ in., paperbound, side-stapled; published by and available from National Society of Professional Engineers, 2029 K St. N.W., Washington 6, D. C.; free to members, 25c per copy to non-members.*

Printed in check-list form, the criteria cover specific categories of engineering career development. The criteria suggest the responsibilities of the employer to his professional employees, and the latter's responsibilities to the employer. Topics include recruitment, indoctrination, professional development of the individual, salaries, engineering titles, personnel practices, and termination practices.

Government Publications

Directory of National Trade Associations. *37 pages, 8 by 10 in., paperbound, side-stapled; published by U. S. Department of Commerce,*

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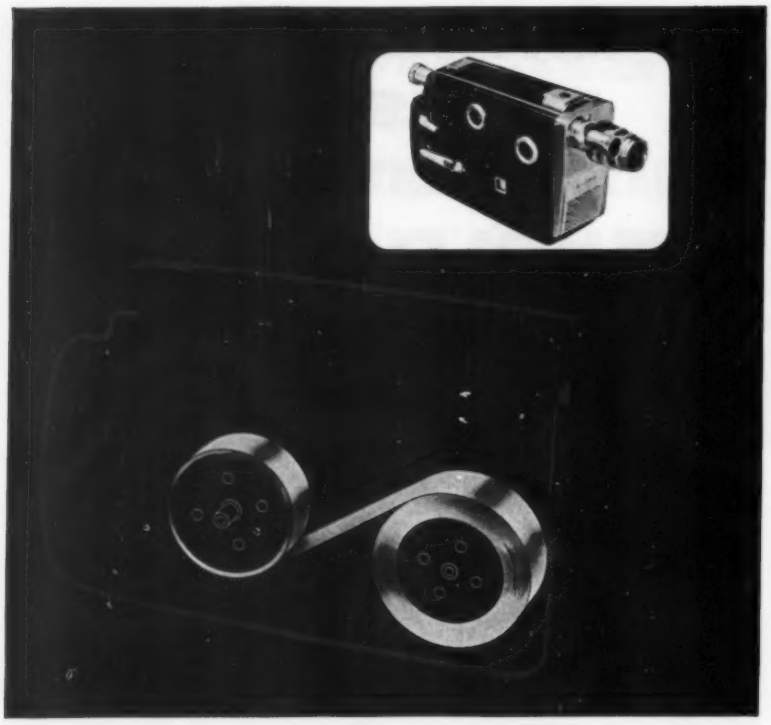

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Washington D. C., and available from Department of Commerce Field Offices; 40c per copy.

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Naval Research Technical Reports. *Each publication is 8½ by 10½ in., paperbound, side-stapled; copies available from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.*

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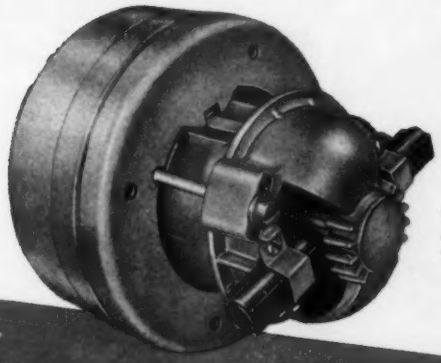

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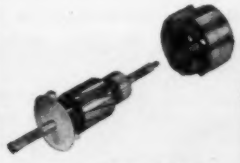
Lightweight motor for portable devices.

Intermittent high torque aircraft motor.



Motor parts for household appliances.

If you are interested in any of the above motors write and we shall be glad to send full information.

New Nylasint® 64 nylon wear parts ... tough, durable, impact-resistant

Nylasint 64 is the newest in the family of Nylasint finely divided nylon powders, bringing new advantages to wear parts formed by the technique of cold pressing and sintering.

Nylasint powders, which can be compounded with various fillers such as molybdenum disulphide or graphite, form parts with these superior properties:

- *High wear and abrasion resistance*
- *Low surface friction*
- *High modulus—resist deformation under load*
- *Low hygroscopic and thermal expansion*
- *High heat distortion temperature*

... plus these advantages in processing:

- *Uniform shrinkage, accurate profiles*
- *Require no degating, have no flash lines*
- *Minimized possibility of stress spots or internal strain*
- *Economical mass production*

For detailed information on your applications, write to National Polymer Products, Inc., Reading, Pa.

POLYPENCO

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Dixon Sintaloy, Inc., Stamford, Conn.
Halex Corp., Plymouth, Mich.

NATIONAL POLYMER PRODUCTS, INC.
A Subsidiary of The Polymer Corporation
Reading, Pennsylvania

New Machines

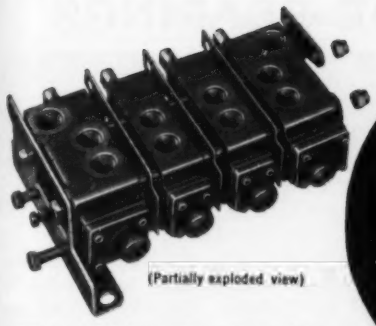
Materials Handling

Strip Stock Feeder: Automatic unit feeds hot or cold laminated plastic and fiber strip stock into any standard blanking press at uniformly controlled temperatures up to 300 F. The machine is particularly useful in the production of parts such as resistors, capacitors, switches, relays, terminal blocks, printed boards and gears. The strip stock rests on a feed belt synchronized with the press through a crank arm to an indexing roll feed. As the bottom strip leaves the machine, the strip above drops into place. Positive butting of the ends reduces the number of partially blanked pieces. An electric heating system, regulated by thermostatically controlled heating elements, brings the stock to desired blanking temperature and maintains it uniformly. *Technical Design & Development Co. Inc., Milford (Devon), Conn.*

Vibratory Feeder: FE ¼ miniature electro-permanent magnetic vibratory feeder is designed for accurate feeding operations where small amounts of materials are involved. It can be supplied with feeder trays of various types which adapt it to operations such as feeding single units at a time, bagging, bottling, and adding reagents to chemical systems. Feed rate is controllable to a maximum of 500 lb per hr (sand). The unit operates directly from 115 v, 60 cycle, ac line. It measures 10¾ x 5 x 6⅛ in. high and weighs 7 lb. *Eriez Mfg. Co., Erie, Pa.*

Metalworking

Gear Grinder: Model 140 reciprocating precision gear grinding machine is designed for grinding external precision spur gears and both right and left-hand helical gears from 8 to 100 pitch. A number of gears of the same type can be ground simultaneously from hardened steel in preformed or solid blanks, or gears can be ground individually. The grinder

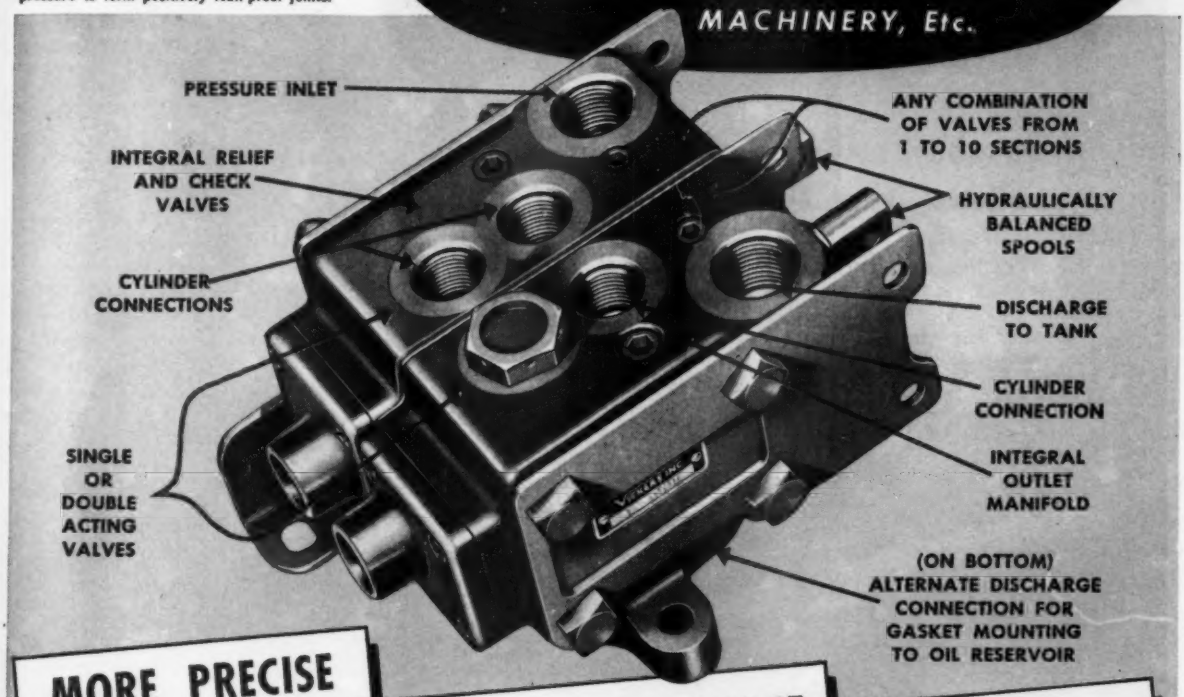


(Partially exploded view)

"O" ring seals between valve sections seal with pressure to form positively leak-proof joints.

Series CM11 VICKERS® MULTIPLE UNIT VALVES

For MATERIALS HANDLING EQUIPMENT, FARM TRACTORS, BUCKET LOADERS, CONSTRUCTION and MINING MACHINERY, Etc.


PRESSURE INLET
INTEGRAL RELIEF AND CHECK VALVES
CYLINDER CONNECTIONS
SINGLE OR DOUBLE ACTING VALVES
ANY COMBINATION OF VALVES FROM 1 TO 10 SECTIONS
HYDRAULICALLY BALANCED SPOOLS
DISCHARGE TO TANK
CYLINDER CONNECTION
INTEGRAL OUTLET MANIFOLD
(ON BOTTOM) ALTERNATE DISCHARGE CONNECTION FOR GASKET MOUNTING TO OIL RESERVOIR

MORE PRECISE CONTROL

Improved Metering Characteristics

REQUIRES LESS SPACE

New Combination Operating-Valve and End-Plate Sections

LOWER COST

Simplified Design and Construction

This is a more compact and versatile design of valve. End sections combine in one casting the inlet or outlet manifold plate together with any operating-valve section. Inlet section also contains relief valve. Individual outlet plates available for single unit valves. Single- and double-operating valve sections can be added between end sections as needed. Valve can be adapted for tandem (series) operation. Single-acting valves available for either direction of lever shift.

Other features include protection of pump from reverse flow during shifting . . . three point mounting for more simple installation . . . cylinder connections with ¾-16 N.F.-2 straight threads (AND 10050 type) help insure leak-proof connections . . . optional outlet ports in end section so valve can be gasket mounted to the oil reservoir or pipe connected. Designed for use with Vickers Series V-200 Vane Pumps (up to 11 gpm), the CM11 Valve can be used up to 2000 psi working pressure. For further information write for Catalog No. M5101-A.

7496

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

TORRINGTON CUSTOM-MADE BEARINGS

"This Torrington design solves my bearing problem!"

Time and again, industrial firms with special bearing requirements turn their assignments over to Torrington—specialists in designing and building custom bearings.

This confidence has been won by years of successful experience. When you call on Torrington, you engage engineers who have devoted tens of thousands of hours to the design and construction of virtually every type of bearing. From their experience—and imagination—comes the *special* bearing that will bring you peak efficiency, service life and economy.

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90th ANNIVERSARY 1865-1955

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller Needle • Ball • Needle Rollers

accommodates a maximum work size of 8 in. OD by 5 in. face width. Maximum length between centers is 15 in. Change gears permit the number of teeth ground to range from 4 to 192. Maximum helix angle adjustment of wheelhead is 45 deg right and left hand. Grinding wheel is mounted on a precision preloaded ball-bearing spindle. Spindle speed is 2100 rpm. Electrical and hydraulic units conform to JIC standards. *Sheffield Corp., Dayton, O.*

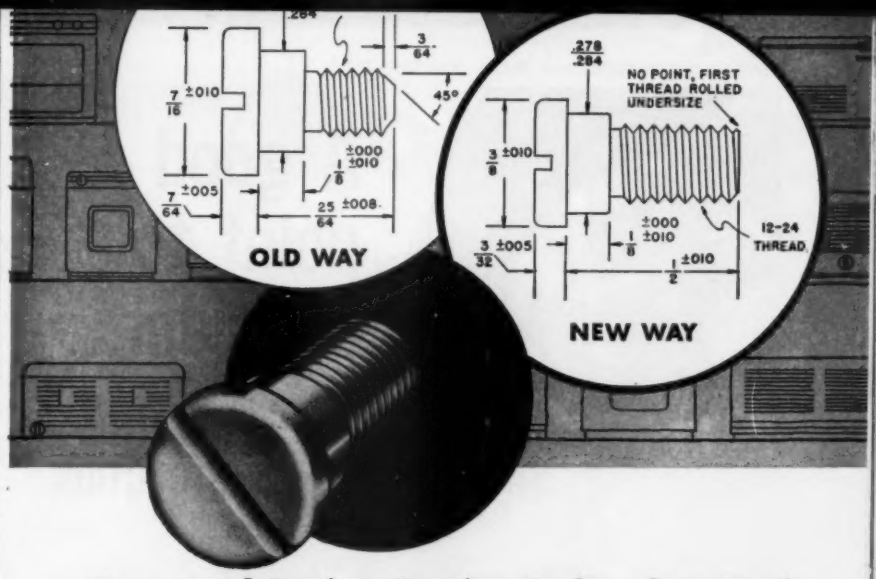
Portable Nibbler: New tool cuts 16 gage corrugated sheet metal at a rate of 33 in. per minute. It also cuts small diameter duct or sheet metal pipe without distorting, curling or flattening of the corrugated curves on either side of the cut. Nose piece and die holder are set at right angles to the body, permitting easy handling of the tool. Diagonal cuts across the curves can be made, and circles as small as 2 in. in diameter can be cut. The unit weighs 7½ lb and is 10 in. long. It has a ½-hp high-speed motor and operates from 110 v ac/dc current, single phase. *Fenway Machine Co., Philadelphia.*

Jig Borer: Starrett optical jig borer has spindle speed range from 70 to 1300 rpm. The unit includes an electric motor and controls, work light, foot pedal, covered table prismatic guides, scales for reading rapid travel of table, and control panel with indicating light and emergency stop. Working surface of the table is 35½ x 12½ in. Longitudinal travel is 19⅝ in.; cross travel, 12½ in.; vertical spindle travel, 7⅞ in. *Aaron Machinery Co. Inc., New York.*

Processing

Portable Welder: R-500 portable welder, equipped with double-pole and single-pole electrode gun, is designed for aircraft applications such as the repair and production of stainless steel-fiberglass insulating blankets and shrouds in thicknesses from 0.002 to 0.020-in. The single-pole gun can be used easily where space limitations prevail, and produces one weld during its operation. Double-pole gun per-

Circle 643 on page 19→



Townsend Design Service Reduced Cost of This Part from $10 to $5 per Thousand

The two parts shown above demonstrate how Townsend engineers saved an appliance manufacturer $5.00 per thousand by redesigning a special fastener so that it could be produced by cold-forming. By redesigning this part a costly machining operation was eliminated.

The shouldered screw at left, above, an integral part of a major appliance, was originally produced by another method at a cost of about $10.00 per thousand. Townsend engineers applied their extensive knowledge of cold-forming techniques to the problem and by slightly changing the design found that the part could be produced for about $5.00 per thousand—a clear savings of 50% on a part used in great volume. The new part shown at right provides just as efficient a fastener as the old.

This is a typical example of how the Townsend Technical Sales Department can help you in your efforts to improve your products and reduce assembly costs. These men can serve you in several ways—they will act as fastening consultants to your design and production engineers—they will design special parts or recommend the best standard fasteners. They often study an entire assembly procedure and suggest improved techniques.

The Technical Sales Department has back of it a company with nearly a century and a half of wire drawing and cold-forming experience. Townsend regularly produces more than 10,000 standard and special parts and fasteners—has the capacity to manufacture more than 60-million pieces a day.

To learn how you may use Townsend services to effect substantial savings in material costs, speed production and improve your products, write today for illustrated bulletins or use the coupon below.

The Fastening Authority

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COMPANY • ESTABLISHED 1816

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Post Office Box 237E
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Please send Technical Sales Department Bulletins TL-89, TL-96 and TL-98.

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Company_____

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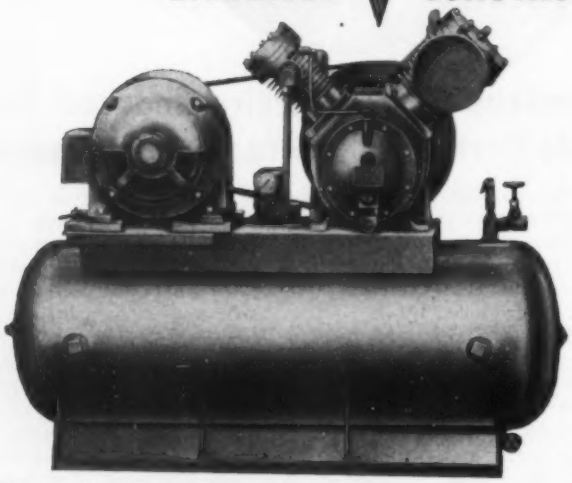
A good point to consider...

BALANCED V CONSTRUCTION



Why the I-R Air Compressor is right for your product!

WHETHER YOU ARE DESIGNING equipment for your own operation or for resale, there are many points about Ingersoll-Rand's *Balanced V Construction* which will help maintain the quality of your air-powered product. These 3 advantages are typical:

1. **Dependable performance.** The I-R compressor is built to operate reliably, quietly, years longer.

2. **Efficient design.** It delivers more air-per-horse-power, size for size, than other compressors.

3. **Looks like Quality** . . . and it is! Compact, well-constructed, durably built, it carries the name and has the quality plant operators expect.

Get more detailed information on I-R Air Compressors—½ to 20 H.P.—to determine the advantages they bring to your own products. For prompt response, write to:

Ingersoll-Rand

3-352 11 Broadway, New York 4, N. Y.

New Machines

mits two simultaneous welds in one operation. Guns are easily interchangeable by means of a disconnecting cable. Retracting arm carries the weight of the cable and permits operation over an area with a radius of 8 ft. The welder operates with a 115 or 230 v ac, single phase, 50-60 cycle power supply. Portable cart is of structural steel construction and has two 12-in. diam wheels. *Joyal Products Inc., Newark, N. J.*

Punching Machine: Redesigned Model 10-AA fabricator, a 20-ton press, punches printed circuit boards. It reproduces any pattern of holes up to 15 x 25 in. area from a master template up to ¼-in. thick. Holes of any shape from 0.030 to 3½ in. diam can be punched cold in most dielectric materials. Good hole quality is assured by close-fitting guides which accurately align punch tip with the die. Template and workpiece are located by means of precision-ground locator pins. The press reciproates at 165 strokes per minute. Punch changes are made in 15 seconds in sizes up to 1¼ in. diam. *Wales-Strippit Corp., North Tonawanda, N. Y.*

Marking Machine: Model 20A cylindrical object marking machine imprints designations on vacuum tubes ranging from miniature glass types to pear-shaped types by means of five different interchangeable chutes. Chutes are marked according to tube types they will accept, together with calibrated scales. Chute feed and automatic ejection provide production speeds from 3000 to 7000 tubes per hr. Precision molded rubber printing elements and marking compounds for glass and metal assure clear imprints. Maximum imprint size is 2⅞ x 6 in. Unit is powered by a ¼-hp motor drive. *Markem Machine Co., Keene, N. H.*

Injection Molding Machine: Model 616-PP-12 plastics injection molding machine molds low-pressure, linear-type polyethylenes as well as other types of plastics. Pre-plasticizer design permits the use of low injection pressures. The pre-plasticizer has a separate power source that can be positioned in a remote location. Operating

Circle 644 on page 19

Circle 645 on page 19→

's SMALLER.... IT'S LIGHTER IT'S RIGHT FOR MODERN EQUIPMENT

Type RK, Capacitor-start, ⅛ or ¼ hp.

the WAGNER "48"

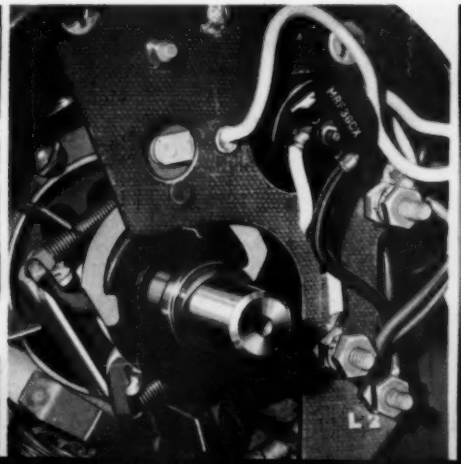
new fractional horsepower motor

Here's the 48 frame motor you've been looking for! The Wagner "48" comes with either resilient or rigid base ... capacitor-start or split-phase type. You get the standard 48 frame size—with from *three* to *eight* pounds less weight per motor than previous models in the same hp ratings! The Wagner "48" is easier to handle... to stock... to install. Yet it's packed with Wagner quality—a known value for more than 65 years.

MYLAR®-PAPER LAMINATED SLOT INSULATION combines top moisture resistance with high dielectric strength and thermal stability—gives the Wagner "48" more application versatility, longer life, when unexpected overloads occur. *DuPont trade mark.

QUICK BREAK SWITCH, that disconnects the starting winding and capacitor from the line at a predetermined speed, makes and breaks with minimum arcing —is dependable and trouble-free.

BABBITT LINED BEARINGS give *smooth* performance. They stand heavy pressures with low temperature rise, have superior anti-seizure and non-scoring characteristics, are corrosion-resistant.



XUM

ALL ANGLE OPERATION. You can mount the Wagner "48" at any angle. A new lubrication system assures positive protective lubrication in any position.

LIGHT WEIGHT STEEL FRAME, precision-machined for accurate endplate fit, combined with CAST ALUMINUM ENDPLATES, gives the "48" strength with light weight.

EASY TO CONNECT. Just loosen one screw for access to terminal board. **EASY TO SERVICE** . . . no need to disconnect leads when removing endplates.

solves problems for the design engineer

For design engineers who've been looking for light weight, fractional horsepower motors with less bulk—here's good news!

Wagner "48" capacitor-start or split-phase motors are rugged enough to permit direct mounting, are compact enough to fit in tight spots, are exceptionally light in weight, and operate efficiently when mounted at any angle. Both types are available with resilient bases or with rigid bases that are *welded* to the steel motor frames to provide great strength. Through ventilation assures cool running motors that last longer.

If you would like to test the new Wagner "48," one of our field engineers will be glad to furnish a sample motor. Contact the Wagner Branch near you or write us.

WAGNER ELECTRIC CORPORATION . . . 6400 Plymouth Avenue, St. Louis 14, Missouri

MS6

the WAGNER "48"

Type RB, Split-phase, ⅙, ¼ or ⅓ hp.

cycle of the machine can be interrupted indefinitely without burning or changing viscosity of material in the heating chamber. The unit dry cycles 360 times per hour, shoots 22 oz of polystyrene (36 cu in.), plasticizes 145 lb of material per hr and exerts 25,000 psi injection pressures. Clamp mechanism provides hydraulic mold-clamping pressures to 200 tons. *Lewis Welding & Engineering Corp., Cleveland.*

Testing and Inspection

Cam Comparator: New 3 D comparator gives readings on both two and three-dimensional cams accurate to ±0.0002-in. Measurements of ±0.0001-in. are possible on highest precision work. The unit gives true readings on an infinite number of specified points and also measures an infinite number of points between stations, compared with a master. The comparator checks 50 to 60 cams per day. It employs a ball probe, exactly the size used for a follower, to trace the contours of the work. Counterbalance maintains constant micrometer pressure on the probe. Master and duplicate cams revolve on a single arbor, and any discrepancy of dimensions is indicated on an air gage. *Parker Stamp Works Inc., Hartford, Conn.*

Contour and Surface Projector: Magnavisa contour and surface projector is designed for the inspection and examination of relatively flat objects and small parts, imprinted circuits and fine print of small-scale drawings. Two models are available—one enlarges the material three times and the other five times. The unit can be used for prolonged periods without eye strain in any normally-lighted area. Materials to be examined are placed on a two-way movable platform. Counterbalanced optical head is lowered into contact and the magnified image is projected onto a uniformly illuminated 4½ x 12-in. viewing screen. Additional areas of the object can be examined by moving the platform in the desired direction. Unit weighs 18 lb, is 21⅛ x 13¼ x 13¼ in. in size. *American Optical Co., Instrument Div., Buffalo.*

THE

simplest answer

TO BEARING PROBLEMS

Bunting capability and leadership in the field of Cast Bronze Bearings and parts are well established and widely recognized. Today Bunting offers an equally comprehensive and responsible service in the field of Sintered Powdered Metal Bearings and parts.

Bunting's special knowledge and facilities make Sintered Powdered Metal products available in many applications not heretofore considered feasible. We can help you find the simplest answer to your individual problem, be it Cast Bronze or Sintered Metal.

A wide range of stock sizes of Bunting Cast Bronze and Sintered Powdered Bronze self-lubricating, plain and flange bearings, thrust bearings and bars are available from Bunting distributors everywhere in America.

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BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS
OF CAST BRONZE AND POWDERED METAL

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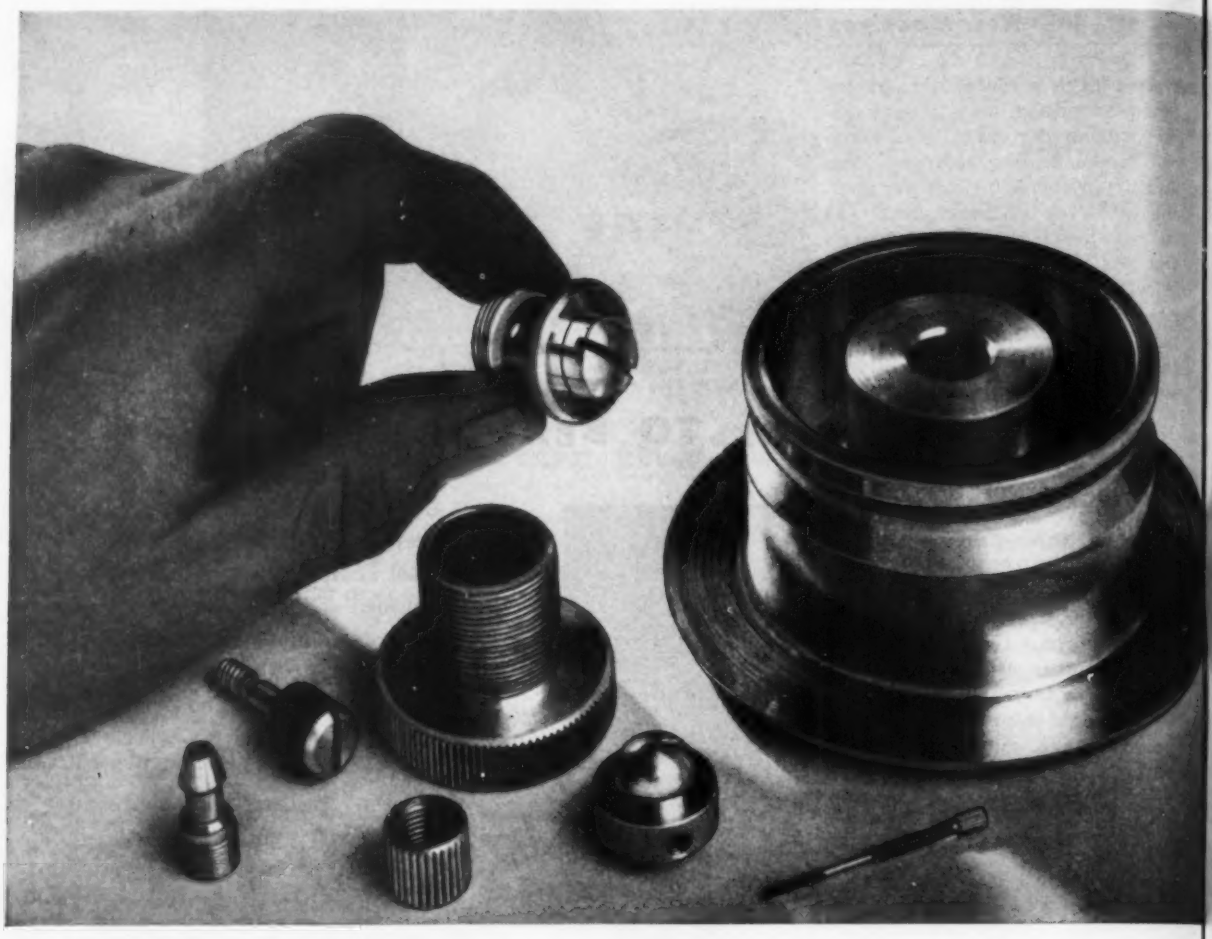


Typical parts machined by Taylor Instrument Companies from Alcoa Aluminum Screw Machine Stock

HOW TAYLOR INSTRUMENTS* GET A LIFT AND A LONG LIFE FROM ALCOA SCREW MACHINE STOCK

Where measurements must be precise, you'll find Taylor Instruments . . . insuring a jet pilot's safe descent by parachute . . . warning a ship's captain of changing weather . . . telling the doctor your temperature and blood pressure. In everyday life, and in thousands of industrial plants, Taylor Instruments have helped America measure its progress since 1851.

What are Taylor's requirements for screw machine parts? Precision, naturally. Corrosion resistance is also important since many Taylor Instruments are installed where maintenance is virtually impossible. Because many Taylor products, like your home thermometer, are mass-produced, cost is exceptionally important in the selection of a screw machine stock.

With these requirements in mind, read why Taylor Instrument Companies use Alcoa® Aluminum Screw Machine Stock. See if their experience plus the inescapable economics of aluminum versus brass doesn't dictate a hard look at all your screw machine parts. For competent technical help in making such an analysis, simply call your local Alcoa sales office listed under "Aluminum" in your classified phone book. Aluminum Company of America, 873-M Alcoa Building, Pittsburgh 19, Pennsylvania.

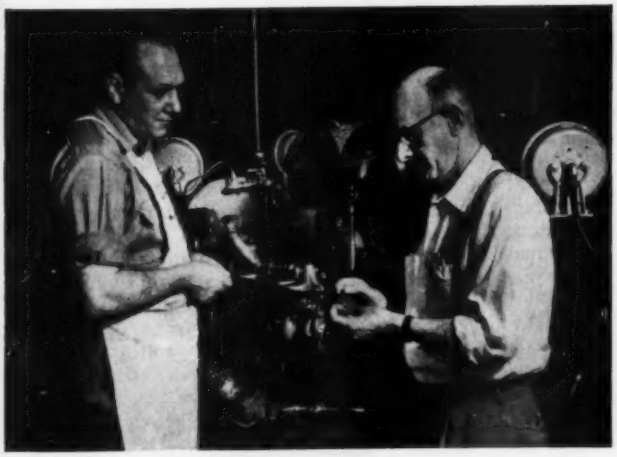
*Taylor
INSTRUMENT COMPANIES

IN PURCHASING

Asst. Purchasing Agent, J. R. Mahan, says, "Dependability is the single most important requirement of a supplier. This we get in full measure from Alcoa. Quality has always been dependable. Deliveries have come when promised. Service and technical help are always available to us and their answers are right. We find this Alcoa dependability also applies to Alcoa distributors from whom we get prompt delivery."

IN METHODS ENGINEERING

H. D. Klitgord, Manager, Methods Engineering Department, says, "We have a continuous cost study of materials for all of our screw machine parts. Equal or better performance has been our criterion in every instance where money could be saved. We are saving $100,000 per year by using aluminum. Our conversion at present is about 40% and we anticipate an increasingly greater use of aluminum bar stock."



IN PRODUCTION

Mr. H. Bubel, Group Leader, Automatic Screw Machine Department, says, "We are machining aluminum at the maximum production rates possible. Alcoa technical people have been of great assistance to us in recommending cutting oils and tools, and helping us maintain our close tolerances and fine finishes."

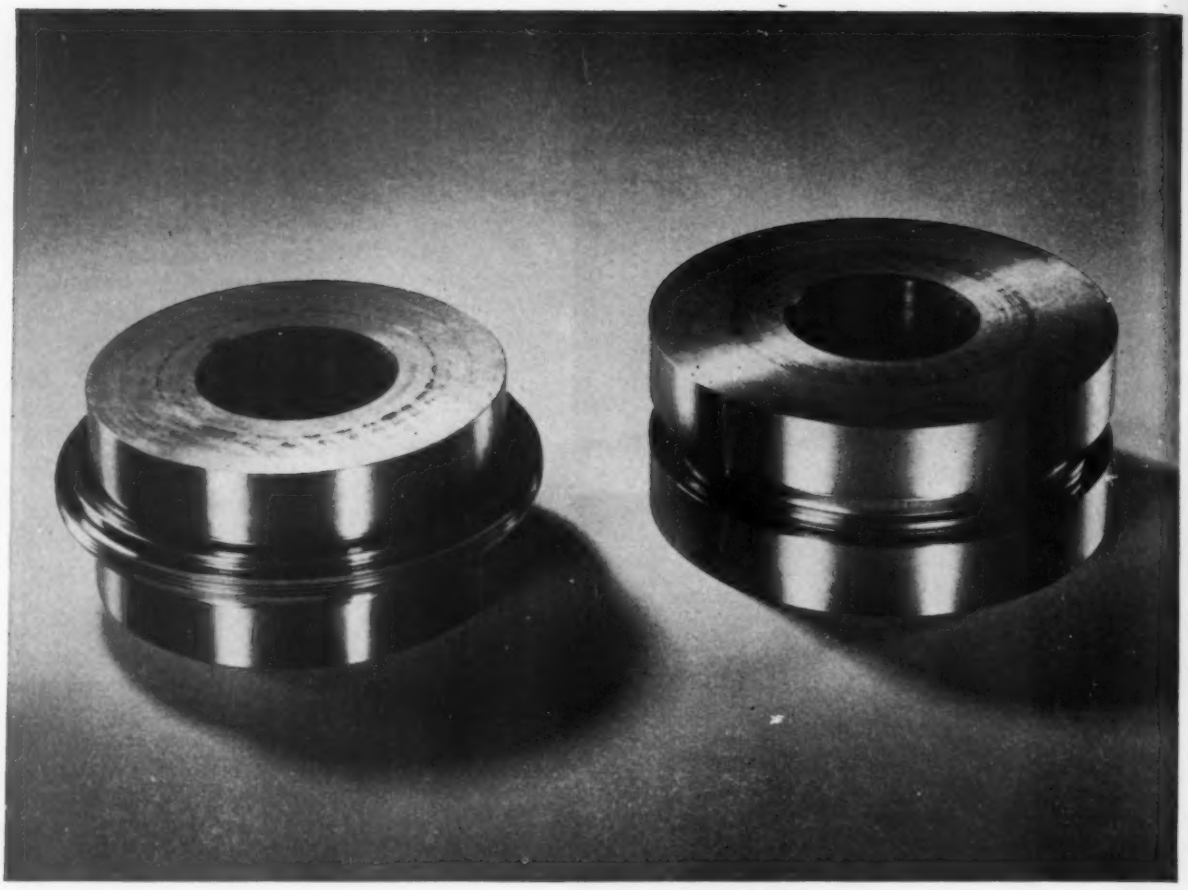
THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM
SCREW MACHINE STOCK
ALUMINUM COMPANY OF AMERICA

Circle 647 on page 19

XUM



how Vacuum Metals FERROVAC solved critical surface problem for Bausch & Lomb...

The jewelers' rolls Bausch & Lomb use to roll gold-alloy wire for eyeglass frames must be *mirror-smooth*. Rolls of conventional air-melted alloys just didn't work out economically. A normal amount of nonmetallic inclusions in the metal meant they had to be ground and reground, polished and repolished, before the surface was satisfactory. And even then, many rolls had to be scrapped when finishing uncovered inclusion pits.

The solution to this problem proved to be Vacuum Metals FERROVAC® Airdi 150. A better finish was obtained without any regrinding—and the number of scrapped rolls fell to zero. Here's why: Vacuum-melting removes the gases which create nonmetallic inclusions in the molten metal before they get into the product. This means cleaner metal, smoother surfaces. What's more, vacuum-melting improves fatigue, creep and impact strengths . . . reduces brittleness.

Vacuum-melted metals are the answer to jobs where surface is critical—like gauge blocks, plug and ring gauges, rolls for aluminum foil—as well as many other specially demanding applications. They're available in most grades and sizes, including special ferrous and non-ferrous alloys. Write now for a free analysis sheet on which to describe your application. It will help us both decide how vacuum-melted metals can serve you best. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, New York.*

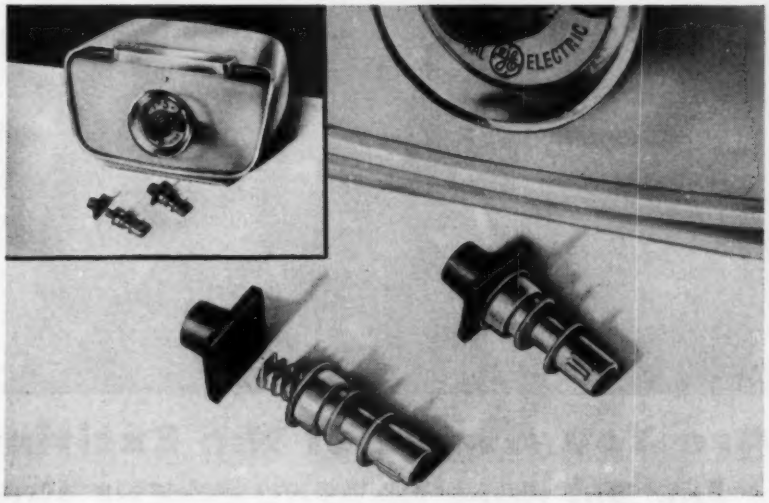
VMC

VACUUM METALS CORPORATION

Division of Crucible Steel Company of America

GE VALUE ANALYSTS SAVE 80%

COMBINE SMALL GRC ZINC DIE CAST AND MOLDED NYLON MATING PARTS



Gries molded nylon nut and zinc alloy die casting form mating units for GE electric blanket control part, at one-fifth the cost of the original expensive screw machine parts.

GENERAL ELECTRIC UTILIZES GRIES' INGENUITY: BUYS PARTS FOR ELECTRIC BLANKET CONTROL AT 1/5TH OF FORMER COST; GRIES TECHNIQUES ALSO IMPROVE PRODUCT'S BASIC DESIGN

Value Analysts at GE's Automatic Blanket Division consulted Gries Reproducer Corp. in an effort to lower cost and improve design of their manufactured products. One result: over 80% savings on the two intricate parts illustrated above now produced as zinc alloy die cast and molded Nylon mating parts.

Gries exclusive techniques made it possible to die cast the threaded shaft—a former screw machine part—with threads, holes and metal-saving indentations as integral parts of the casting, delivered ready-for-use.

The GRC Nylon part, formerly a special screw-machine brass nut, is now molded in one integral piece with accurate, *molded*, internal threads.

The combination not only results in superior part performance but the overall savings on these two components is over 80%.

This is only one example of the many types of savings that Gries' unique methods are affording industries in the production of better and more economical small parts.

These examples illustrate how well GRC, as a single source of supply, can precisely "mate" parts, even of different materials.

GRC again demonstrates its ability to supply industry with tiny parts at lower cost—with additional built-in economies and superior performance.

Informative Die Casting Bulletin Gives Examples, Facts from Gries

Gries' fact-filled die casting bulletin shows many examples of how GRC may help you solve your small parts problems. It also tells about GRC's design engineering services for the solution of specific problems. Send for this bulletin today or, send prints for prompt quotations on quantities of 100,000 to many millions — completely trimmed, ready to use, precision made die cast parts. Smallness of Gries die castings is unlimited; maximum weight ½ oz., maximum length 1¾ in.

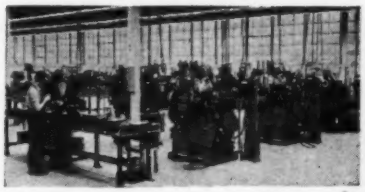
Gries' Tiny Molded Plastic Parts Offer Wide Design Latitude

The infinite possibilities offered by Gries' methods in molding tiny plastic parts offer design engineers almost unlimited latitude in their designs.

GRC molds all thermoplastics—Nylon, Kel-F, acetates, polystyrene, polyethylene, etc., with Nylon a specialty. Maximum length 1¼"; maximum weight .03 oz; minimum unlimited.

A new bulletin is now available giving complete details of Gries Plastics Molding Division. Send for it today.

Gries Reproducer Offers Complete Production Facilities



Included in the many facilities offered at the modern Gries plant are complete departments for performing secondary operations such as tapping, drilling, assembling, reaming, and special machining. Practically all commercial finishes can be applied in GRC's specialized plating department.

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

GRIES

GRIES REPRODUCER CORP.

32 Second St., New Rochelle, N. Y. • New Rochelle 3-8600

Circle 649 on page 19

Are You Aware of the Exciting Opportunities for Product Improvement that Exist Now?

Today, industry is forging ahead in the development of products little dreamed of only a few short years ago.

Instrumentation . . . miniaturization . . . more automatic production . . . all are demanding parts and components with new operating advantages. And High Nickel Alloys are playing an important part in meeting the needs. Are *you* aware of the opportunities High Nickel Alloys offer? For example, do you know you can . . .

. . . Design smaller, lighter weight units through the use of "extremely sensitive" alloys that respond to very weak electrical currents?

. . . Assure precision product performance with the help of an alloy that exhibits infinitesimal size change through temperature ranges up to 400°F?

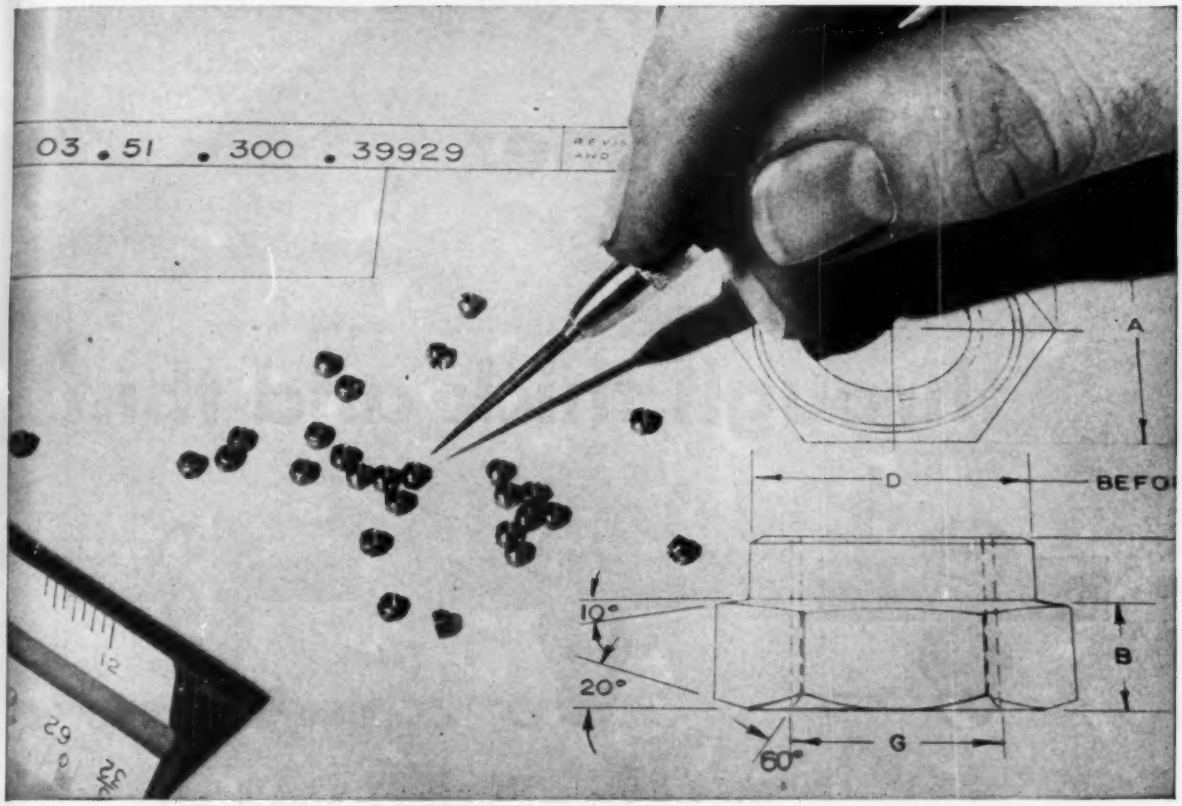
. . . Compensate a given magnetic field for temperature changes to insure consistently accurate product performance?

And the list goes on . . . an exciting list of properties that can lead to rewarding fields of new and improved products!

Getting High Nickel Alloys to do special jobs for you . . . making them behave in the way *you want them to behave* . . . is an opportunity we welcome. By making a team of your engineering experience and Carpenter's ability to produce closely controlled High Nickel Alloys with predetermined behavior, you often take an immediate step to product improvement. To help you in this job, Carpenter manufactures an unusually complete line of High Nickel Alloys . . . Temperature Compensator, Low Expansion, High Permeability and Glass Sealing Alloys. These are available in the largest variety of forms including strip, wire, bars, tubing, forging billets, etc. Ask for detailed engineering and application information. A note on your company letterhead is all that's necessary.

Carpenter STEEL — High Nickel Alloys

Pioneering in Improved Tool, Alloy and Stainless Steel Through Continuing Research
THE CARPENTER STEEL CO., 120 W. Bern St., Reading, Pa.
Export Department: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"



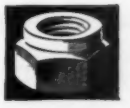
FLEXLOC MICROSIZE locknuts meet designers' needs for tiny precision nuts that retain strength and holding power in the smallest assemblies—servomechanisms, electronic and electrical equipment, all miniature devices.

New FLEXLOC Microsize Locknuts

Now available in Alloy Steel, Stainless Steel, Brass and Aluminum for lighter, more compact designs

SIZE	Across Flats		Shoulder Height		Across Corners	Height +.000 −.003
	MAX.	MIN.	MAX.	MIN.	MIN.	
0-80 NF-3B	.111	.107	.047	.042	.123	.075
1-64 NC-3B	.127	.123	.0635	.0585	.141	.090
1-72 NF-3B	.127	.123	.0635	.0585	.141	.090
2-56 NC-3B	.158	.153	.068	.063	.176	.105
2-64 NF-3B	.158	.153	.068	.063	.176	.105
3-48 NC-3B	.190	.183	.071	.066	.210	.120
3-56 NF-3B	.190	.183	.071	.066	.210	.120
4-40 NC-3B	.190	.183	.072	.067	.210	.120
4-48 NF-3B	.190	.183	.072	.067	.210	.120

SPECIFICATIONS: Available in brass (plain or cadmium plated) and aluminum (plain or chemically treated), for temperatures to 250°F; alloy steel, 18-8 stainless, for temperatures to 550°F.



New FLEXLOC Microsize locknuts are smaller and lighter than regular FLEXLOCS of the same nominal diameter. Wrenches of smaller size are used to install them. Mating joints or flanges can be designed smaller—with no loss in strength or convenience of assembly.

Microsize FLEXLOCS have all the advantages of larger FLEXLOCS. One-piece, all-metal construction—nothing to put together, come apart, lose or forget. Use them as lock or stop nuts—they stay put anywhere on a threaded member as soon as the locking threads are fully engaged. Uniform locking torques insure accurate preloading. There are no nonmetallic inserts to pop out or deteriorate. Moisture, dryness, oil won't affect these Microsize FLEXLOCS. Just screw them on. They lock and stay locked. Vibration won't shake them loose.

For complete information on Microsize FLEXLOCS, consult your authorized SPS distributor. Or write STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

STANDARD PRESSED STEEL CO.

FLEXLOC LOCKNUT DIVISION SPS

JENKINTOWN PENNSYLVANIA

Circle 651 on page 19

This fastener works through thick and thin!

Spring-Lock—the easy-to-use removable fastener for modern designs—works whether panel thicknesses run over or under specifications! Spring wire deflects automatically to handle greater or lesser thicknesses. Spring-Lock's design flexibility makes it more than a fastener: it can be adapted as a shelf support, door strike, knob or any similar panel-mounted device. Many standard shapes and sizes of Simmons Spring-Locks are available from stock.

SIMMONS FASTENER CORPORATION

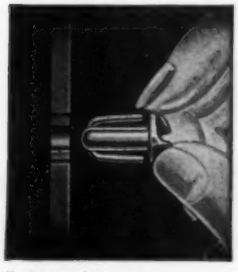
1756 North Broadway, Albany 1, New York

Simmons

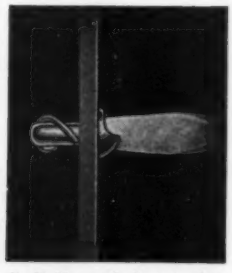
QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

HERE'S HOW SPRING-LOCK WORKS



1. *Insert fastener.*



2. *Half-turn locks it in place.*

With production costs on the uptrend, you can figure on Spring-Lock as an assembly time and money-saver, because:

- **Installation is BLIND**
- **Installation is EASY: no special tools are needed**
- **Installation is QUICK: a half-turn locks it in place**
- **Installation is SECURE: the *spring* steel *locks* the fastener, resists vibration**

Send for details and samples, or write us about *your* fastening problem.

to engineers who are quite particular about their jobs...

YOU TELL US...

WHAT DO YOU REQUIRE IN A JOB?

For years we have been offering various types of positions to engineers through the pages of this magazine.

But perhaps there is a better way. Perhaps you should tell us what you want in a job.

Tell us what you seek: type of work, salary, level of responsibility, working conditions, everything important to you.

Then let us try and find that position for you from among the hundreds now open in our company. With openings in virtually every field of engineering, on virtually all levels, we believe we can match many of your job descriptions with the actual position.

Naturally, we can't place an engineer with one year's experience in the position of a 10 year man. But in many cases, we'll be able to offer interesting promotion. We'll be able to offer you refreshing changes in type of work — and through our training programs, enable you to make the change you desire. In brief, we think we can give satisfaction to a majority of reasonable inquiries.

The brief résumé form below is for your convenience in responding. Please feel free to amplify on it.

California Division

LOCKHEED

AIRCRAFT CORPORATION • BURBANK

CALIFORNIA

Circle 653 on page 19

E. W. DES LAURIERS, DEPT. 9054
LOCKHEED AIRCRAFT CORPORATION
BURBANK, CALIFORNIA

Here is the position I seek:

Field of engineering (please be as specific as possible)

Salary

Educational opportunities (on-the-job training, university courses leading to advanced degrees, company training in specialized subjects, whatever programs you need for advancement of your career)

Name

Home address

City and State Age

Home phone

(Advertisement)

When selecting a timer— design for availability

Specifying one of the many standard units offered saves you and your customers time, money

Several distinct advantages accrue when you design for a standard timer—as against making a special timer for your specific job:

Cost is lower because no engineering or tooling charges are encountered. Service is quicker and easier. Replacement is simplified. Complete descriptive information and operating instructions are in print.

STOCK TIMERS FOR QUICK DELIVERY. But probably the most important single reason for sticking to standards is ready availability. Quantities of the exact type, range and rating can usually be obtained immediately from manufacturer's stock for prototype or test purposes. Production quantities can be supplied with minimum lead time because design has been completed, parts inventories established and assembly techniques perfected.

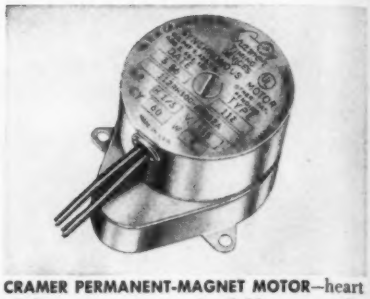
EXTREME VARIETY AVAILABLE. Leading timer manufacturers offer extremely wide lines of standard interval timers, time delay relays, cycling timers and time totalizers. In addition, a wide selection is offered within these groups. You can, for instance, pick a standard interval, cycling or delay timer to optimize almost any characteristic needed for your design; cost, mounting, accuracy, actuating means, and degree of adjustability. Each of these sub-categories in turn provides various time ranges, control arrangements and voltage-frequency combinations.

MINOR CHANGES EASY. In the event you can not find a stock or catalogued timer to meet your exact needs, discuss your problem with a full-line timer manufacturer. He will frequently be able to modify a similar unit to your specifications with only minor changes, thus saving you the costs of engineering and lengthy testing.

Only rarely will you have to specify a completely new design. And then your best approach is to talk it over with the specialists in the field of time control.

WRITE TIMER SPECS EARLY. Timer requirements should be determined early in the design process, so that an available standard timer, with the right characteristics and proved performance, can be accommodated.

LET US HELP YOU. Cramer engineers are always ready to discuss your time control problems. They can tell you about interval timers, time delay relays, cycling timers and time totalizers in 85 stock variations in the wide Cramer line. And they can handle your special needs, too. Write us or see your local Cramer representative. The Cramer Controls Corporation, Box 6, Centerbrook, Conn.



CRAMER PERMANENT-MAGNET MOTOR—heart of Cramer a-c timers. Available separately. Features fast start, truly synchronous operation, no coasting. *STOCKED* in many speeds, right or left rotation. Various output shafts. Torque: 30 in-oz at 1 rpm. Bulletin PB-110A.

A FEW STOCK TIMERS FROM THE BROAD CRAMER LINE

1. TYPE 631E TIME TOTALIZER. Registers elapsed time on 5-digit drum-type counter. *STOCKED* in total ranges of 9999.9 and 99999 hours at 115V, 60 cps. Also 9999.9 hours at 220V, 60 cps. Other available (including resettable) types count 1/10 seconds, seconds, 1/100 and 1/10 minutes, minutes, 1/10 hours and hours. Bulletin PB-610.

2. NEW TYPE 412 TIME DELAY RELAY. Introduces timed delay between operation of control circuit and load circuit. *STOCKED* in full-scale ranges of 6, 15, 30, 60, 120 seconds; 5, 15, 30, 60 minutes; 5, 12, 24 hours at 115V, 60 cps. Also 15, 60 seconds; 5, 15, 60 minutes at 220V, 60 cps. Bulletin PB-311.

3. NEW TYPE 241 AUTOMATIC RESET INTERVAL TIMER. Provides pushbutton start, automatic and immediate reset for electrically operated equipment. *STOCKED* in full-scale ranges of 6, 15, 30, 60, 120 seconds; 5, 15, 30, 60 minutes; 5, 12, 24 hours at 115V, 60 cps. Also 60 seconds; 5, 15, 60 minutes at 220V, 60 cps. Bulletin PB-241.

4. TYPE 610 PERCENTAGE TIMER. Makes (or breaks) electrical circuit for adjustable percentage of a fixed time period. Calibrated in steps of 1% from 4 through 96. 100% setting provided. Snap action switch. *STOCKED* in ranges of 15, 30, 60 seconds; 5 minutes at 115V, 60 cps. 15, 30, 60 seconds at 220V, 60 cps. Bulletin PB-510A.

TALK IT OVER WITH CRAMER

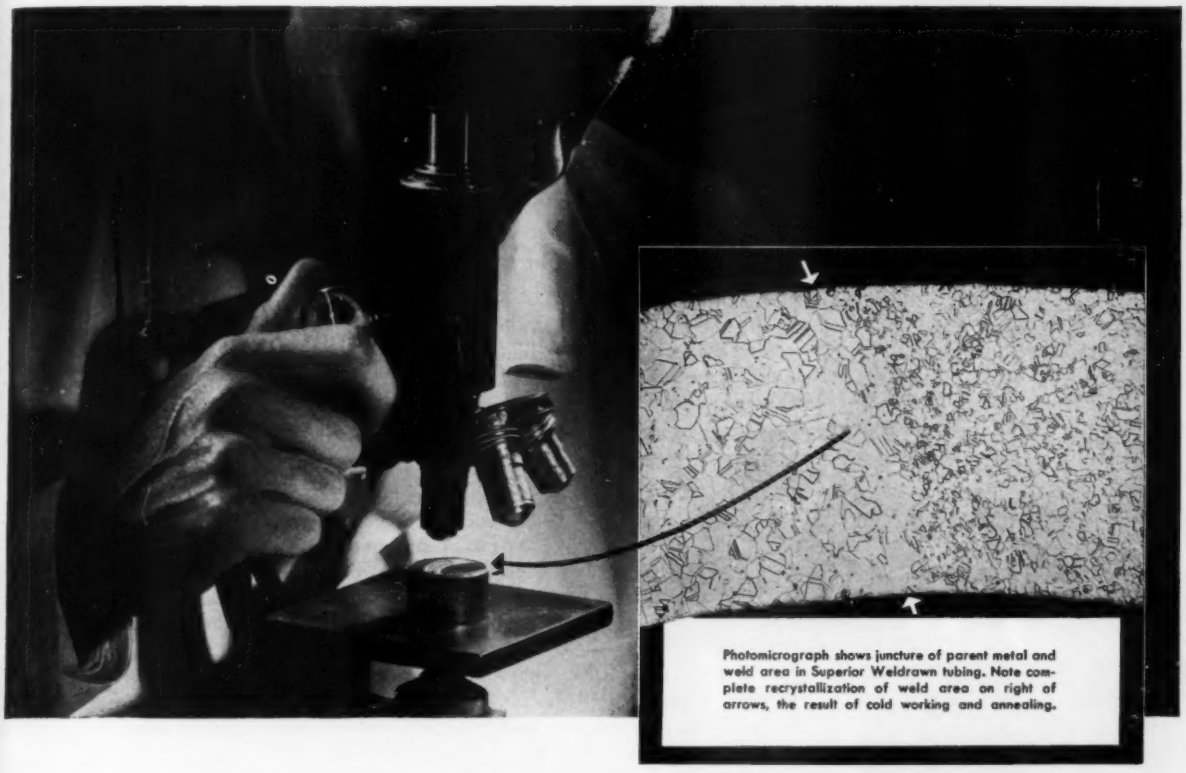
CRAMER CONTROLS

CORPORATION

(Formerly R. W. Cramer Co.)

4.16

Weldrawn® Tubing *by* Superior



Photomicrograph shows juncture of parent metal and weld area in Superior Weldrawn tubing. Note complete recrystallization of weld area on right of arrows, the result of cold working and annealing.

So perfect the bead actually vanishes!

Here's how to cut tubing costs up to 50%

Specify Superior Weldrawn. You get quality approaching that of seamless, at savings as high as 50%! Unlike other welded tubing, Weldrawn is offered in *any* of the intermediate sizes—made possible because of the redrawing after welding.

"Weldrawn" Means—

This is a tubing far superior to ordinary welded tubing for many applications requiring forming, machining and corrosion resistance. After welding, it undergoes alternate cold drawing and annealing.

The weld area recrystallizes (see photo above), acquiring mechanical properties equivalent to those of the parent metal. The bead actually vanishes!

Costs Are Low

Weldrawn tubing is produced in 18 different analyses, in a wide variety of sizes. Cost savings are 10 to 20%. In certain materials you save up to 50%!

Quality Is High

In Weldrawn you get tubing with highly uniform mechanical properties throughout, and clean, smooth, bright ID and OD surfaces. Because no filler or flux is used during welding, the corrosion resistance of the weld area is equal to that of the parent metal. And by repeated redrawing and annealing after welding, any possible faults or defects in the weld are eliminated.

Specify Superior

In addition to Weldrawn tubing, we also offer a wide variety of analyses and sizes in Seamless grade. So for the finest in small tubing, always specify Superior.

Whatever your problems in small tubing, Superior can help you. For additional information on Weldrawn, write for Data Memorandum No. 2. Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses available in .010 in. to ½ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

MONSANTO

Today's industrial designers work closely with plastics engineers in solving many complex design and production problems. Here is a graphic example of contributions being made by custom-molding craftsmen.

Resinox® thermosetting plastic helps IBM electronic "brains" perform amazing feats of "memory"

DESIGN OBJECTIVE IBM's blue-prints for its new 704 and 705 Electronic Data Processing Machines called for special frame assemblies to house thousands of tiny magnetic "memory" cores, strung on grids of coordinate wires, which attach to terminal inserts in the sides of the frames.

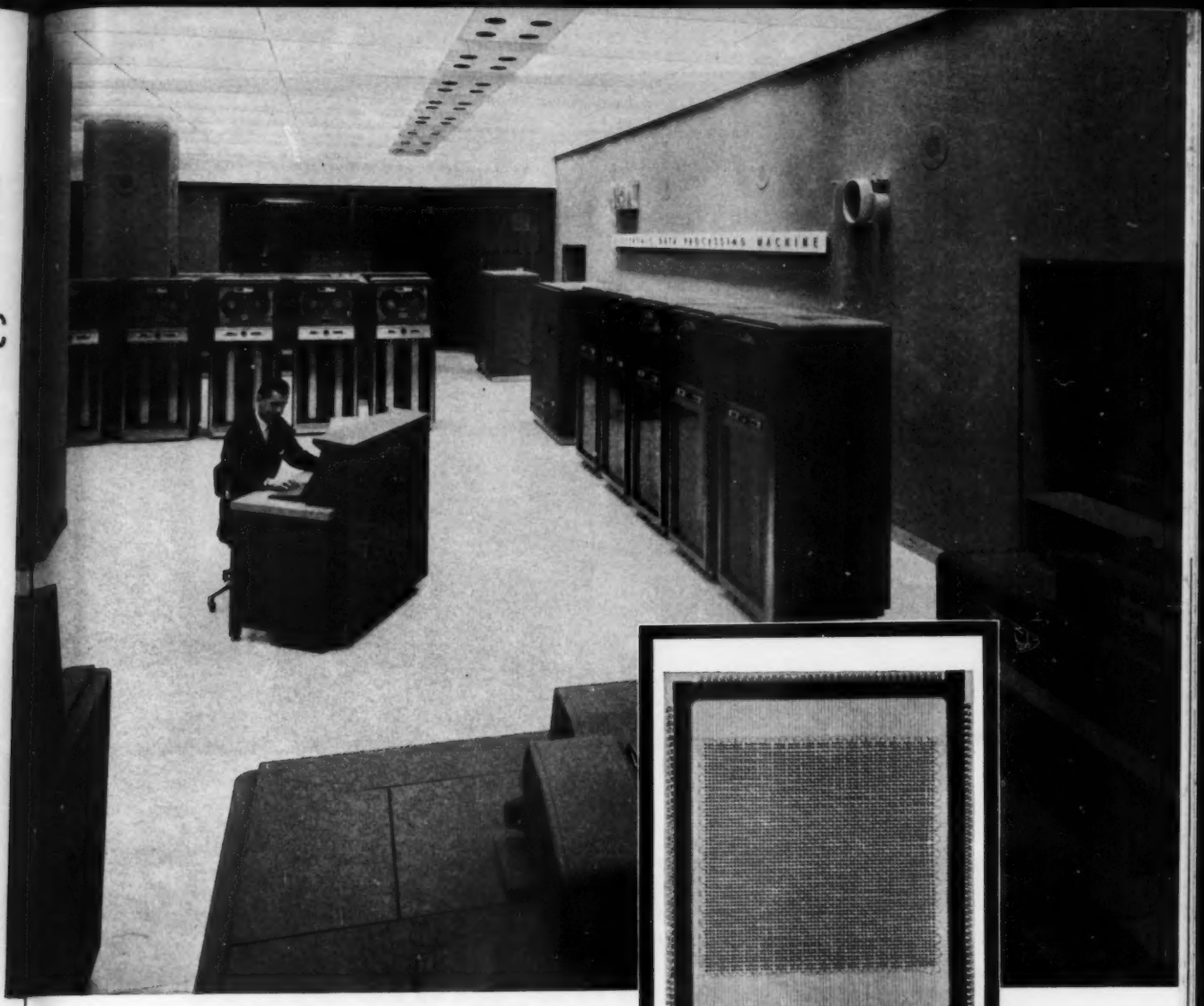
MATERIAL SPECIFICATIONS In setting up specifications for the frame material, IBM design engineers had to consider many factors. For one thing, since the memory frames were to be stacked 35 and 36 high, no frame could deviate in flatness beyond .030 inches in the 10 inch frame length. Shrinkage also must be predictable within fine limits. Rigidity was another requirement. Although light in weight, the frame was expected to withstand up to a pound's pull from each of the wires—and there are 68 grooves for wires on the short side, 86 along the length! Next, production called for the 308 terminal posts set in the edges of each frame, to be hot-dipped in a lead-tin mix at 550°F. without distortion of the plastic. And finally, of course, the frame material must possess superior dielectric strength and other electrical properties.

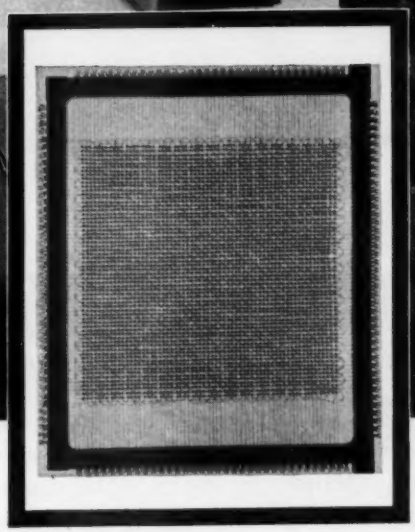
...oosening metal wedges from memory frame.

PRODUCTION ENGINEERING Specialty Insulation Manufacturing Company, Inc., Hoosick Falls, N. Y. was awarded the job of molding the frames. SIMCO engineers, after long thorough investigation, selected Resinox 3700 as the frame material. Less expensive than other materials tested, this Monsanto thermosetting plastic was easier to handle, easier to transfer mold. Its electrical characteristics passed IBM's tests. It possessed excellent dimensional stability, stayed flat, rigid. Resinox 3700 had an extremely low predictable shrinkage. Its heat resistance permitted hot dip soldering.

The frames are being molded of Resinox 3700 in conventional 100-ton transfer-molding presses. A molding temperature of 310°F. is used. Molding time is two minutes. Loading 9 oz. of Resinox in the press is accomplished by first preforming the powder into six 1" x 2" pills, then preheating the pills to 275°F. in an electronic preheater for 10 to 15 seconds.

XUM





THE FINISHED PRODUCTS These two new and advanced IBM Electronic Data Processing Machines, which can remember up to 40,000 letters, numbers or symbols and can recall facts in a few millionths of a second, are solving many highly complex business and scientific problems including ones connected with top defense projects. One machine, for example, is making high speed calculations in jet engine design. Another is being installed for use in nuclear weapon development. A third is involved in the design of gas turbines.

The contributions that plastics custom molding craftsmen have made in the development of this giant electronic "brain" are being repeated in hundreds of cases in all phases of industry. The skills and services of these 20th Century craftsmen are available to every manufacturer designing for greater efficiency and lower costs. As a major supplier of plastic resins, Monsanto is in a position to direct you to custom molders who can bring long experience and detailed knowledge to bear on your problems. Write to Monsanto Chemical Company, Industrial Applications Dept., Room 611, Springfield 2, Mass.

MONSANTO

RESINOX®

Investigate Monsanto's completely balanced line of phenolic plastic compounds developed for particular applications and sold under the trade name Resinox.

Circle 656 on page 19

Two at a time...

Wastebaskets molded for higher production... lower cost

A major manufacturer of metal housewares decided to broaden his line by adding plastic wastebaskets. His first step was to call in a Nosco sales-engineer . . . logical, because Nosco men are qualified plastic-parts technicians who know exactly how to put Nosco engineering and production facilities to work. The Nosco plant thus becomes the customer's own plastic molding department!

For the 8-quart basket, Nosco engineered *the deepest two-cavity mold ever built*. This hot-runner mold, which virtually eliminates all scrap, weighs more than a ton and is run in one of Nosco's large pre-plasticized presses.

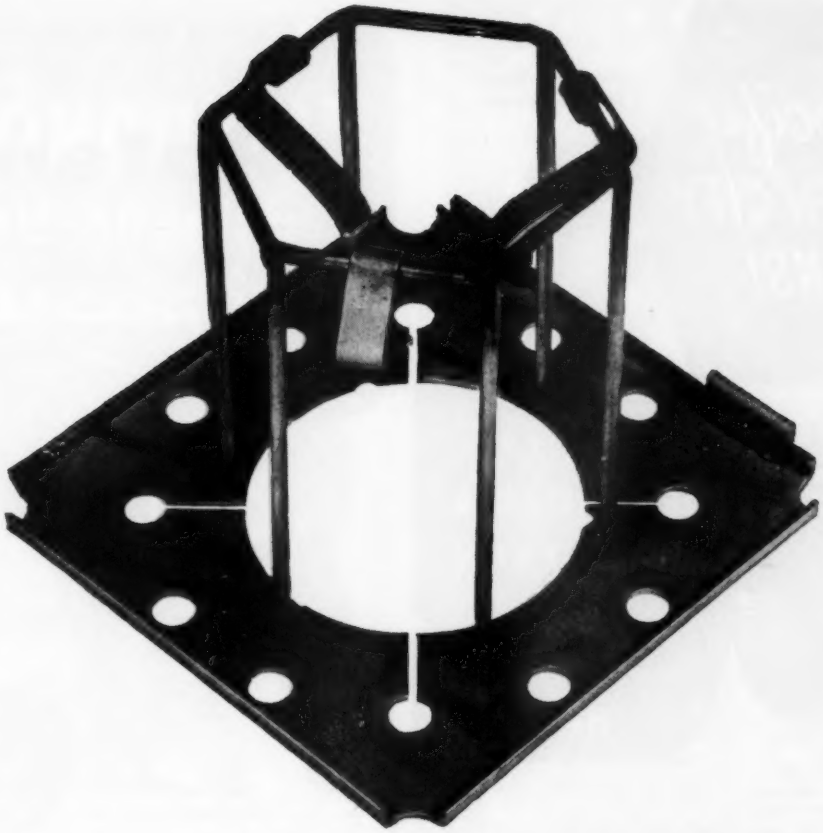
The two larger size wastebaskets, pictured above, are now molded one at a time, but when production warrants, these parts can also be molded in two-cavity dies.

Nosco "Can Do" enabled this manufacturer to successfully produce deep-drawn parts at lower cost. Why not let one of our sales engineers put Nosco "Can Do" to work in designing your next plastic part? Please write.

NOSCO plastics, inc. • erie 2, pa.

World's largest injection molding plant

For other case histories—and for a glimpse of the Nosco plant and facilities, send for the free 12-page brochure, "How the Nosco Plant Works to Produce Your Needs in Pratical Plastics."



Still in Use after 1½ Years
of Heating and Quenching

This tray, made of a HAYNES high-temperature alloy, has been subjected to continual heating and cooling for 18 months . . . and it is still in good shape.

In the heat-treating operation, trays and rings are heated to 1550 deg. F for a half hour and then given a rapid oil quench. This repeated exposure to high temperatures and thermal shock caused other trays to twist out of shape in a few days.

The HAYNES alloy used to solve this problem was HASTELLOY alloy C. There are 10 other HAYNES high-temperature alloys—each designed to resist certain severe operating conditions. All of the alloys have remarkable strength at high temperatures, coupled with excellent oxidation resistance and dimensional stability. One of them may be the answer to a production or maintenance problem in your plant.

For information on prices, available forms, and properties of these alloys, write to our general sales office in Kokomo, Indiana or to any of the District Sales Offices listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works, Kokomo, Indiana

Sales Offices

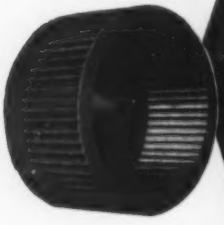
Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

"Haynes" and "Hastelloy" are registered trade-marks of Union Carbide and Carbon Corporation

Specify GARDEN CITY FANS!

Standard Steel Plate Exhauster

Design B Multiblade (Forward Curve)



There's a DEPENDABLE GARDEN CITY FAN for every need

Want efficient movement of air?

Send your O.E.M. specifications to Garden City's engineers!

- **More advanced design**

  77 years experience in making fans! Designs are simple, scientific, proven.

- **Tougher, thicker steel**

  Stamina to endure thru the years! Heavy gauge steel which resists abrasion and corrosion for a longer period of time.

- **Lower maintenance costs**

  These rugged fans stand up under roughest conditions. Sturdy construction requires minimum maintenance.

- **Remarkable performance**

  High temperature fans will move hot gases up to 1650 F. Air-cooled shaft saves dollars on your bearings-upkeep.

WRITE TODAY FOR CATALOG . . . and ask to see long list of blue chip industries using Garden City Fans

GARDEN CITY FAN COMPANY
ESTABLISHED 1879

332 S. Michigan Ave.
Chicago 4, Illinois
Dept. G

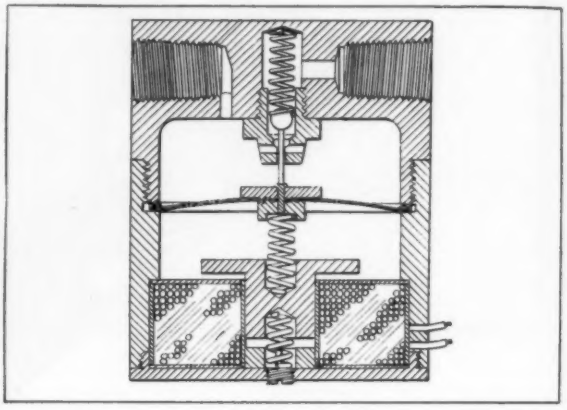
Representatives in Principal Cities

• Fans for Industry • Backward Curve • Forward Curve
• Material Handling • Radial Bladed • Small Exhaust

NOTEWORTHY Patents

Dual-Range Pressure Regulator

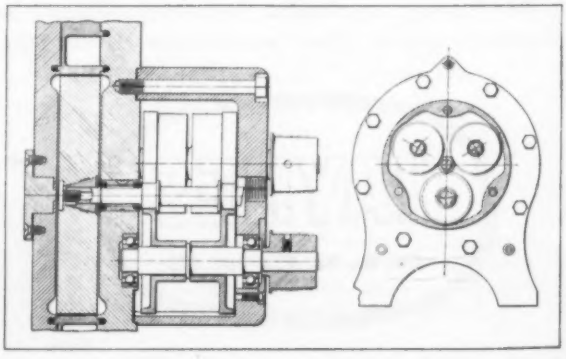
Regulated pressure at either of two flow rates is provided by a dual-range, electromagnetically operated pressure regulator. Combining functions of a pressure regulator and a high-low metering valve,



the unit finds application in the control of gas or liquid-fuel burners, or in similar installations that require pulsation-free flow at two different volume levels. Regulator establishes minimum flow rate when solenoid is energized; maximum rate operation corresponds to the de-energized state of the solenoid. *Patent* 2,764,996 *assigned to Hupp Corp. by Richard J. Brown.*

Ultrahigh-Speed Drive

Output speeds ranging from 100,000 to 200,000 rpm are developed by a high-speed drive unit that operates with minimum vibration and wear. Comprising three stub-shaft-mounted input drive rollers in frictional engagement with the surface of the output shaft, the unit employs dynamic-damping devices in the roller interiors to suppress vibration at critical



"MONOBALL" Self-Aligning Bearings

PATENTED U. S. A.
All World Rights Reserved

CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Moly Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Moly Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. Address Dept. MD-56.

SOUTHWEST PRODUCTS CO.
DUARTE, CALIFORNIA

Circle 660 on page 19

molded Brush Holders

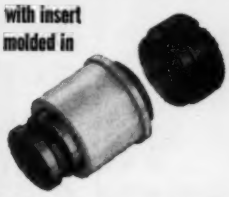
Now Available MOLDED NYLON as well as Phenolic

supplied from stock

to help motor makers

build better motors

EXTERNAL THREAD?
with insert molded in



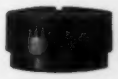
INTERNAL THREAD?
with insert molded in

MOLDED THREADS?
on holders and caps

BRUSH CAPS TO FIT?

Internal or External Thread

Many Stock Sizes



MOLDED COMMUTATORS?

with or without prongs or segmented

Complete Range of Stock Sizes

Send Blueprint for Quotation

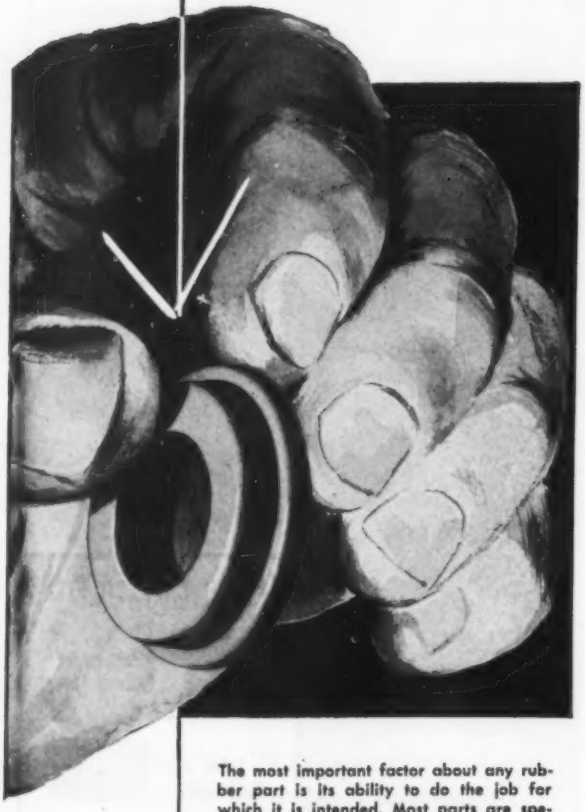
Midwest Molding AND MANUFACTURING COMPANY
GURNEE 98 ILLINOIS

Chicago Phone: Dickens 2-0777
Long Distance: ONtario 2-1320

PLASTICS • TOOLING • COMPRESSION • INJECTION

Circle 661 on page 19

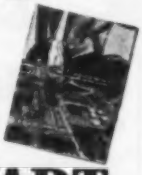
DOES
THIS
RUBBER PART
BELONG IN
YOUR PRODUCT?



The most important factor about any rubber part is its ability to do the job for which it is intended. Most parts are specifically engineered for the application . . . and consideration is given to elasticity, temperatures to be encountered as well as resistance to petroleum derivatives, chemicals and abrasion.

STALWART ENGINEERS have the experience and facilities to compound special rubber stocks to meet even the most unusual requirements . . . and from more than 500 different compounds already at their disposal, they can mold, extrude, die-cut, lathe-cut or mandrel-build shapes to meet any specifications.

SPECIFY STALWART RUBBER PARTS FOR THAT ONE ESSENTIAL QUALITY . . . THE ABILITY TO DO A JOB . . . BEST!



Write today for catalog 56-SR-3

STALWART
RUBBER COMPANY
180 Northfield Road • Bedford, Ohio

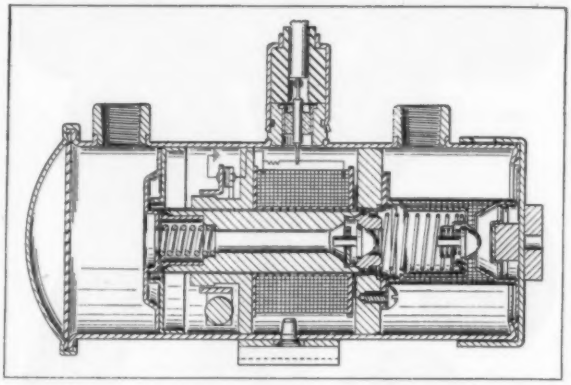
6905-SR

Noteworthy Patents

speeds. Use is intended in high-speed instrument and machine applications. *Patent 2,765,665 assigned to Beckman Instruments Inc. by Edward Pickels and Philip F. Scofield.*

Electromagnetic Pump

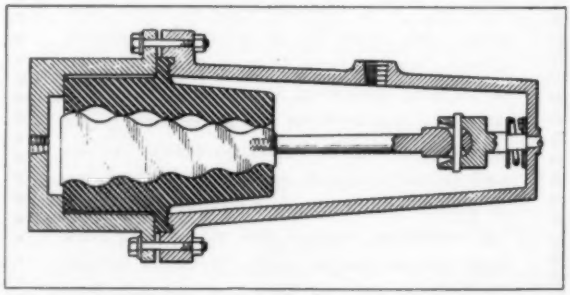
Suspensions of nonfilterable abrasive substances—for example, mud or dirt—have negligible effect on the operating life of an electromagnetically actuated,



plunger-type pump. Contamination of plunger-cylinder wearing surfaces is minimized by the squeegee action of flared, wool-felt sealing rings mounted at both plunger ends. Particles not removed by this action are trapped beneath the surface of the felt without affecting its nonabrasive wiping characteristics. Transfer of liquid from inlet chamber (right) to outlet chamber (left) is accomplished by action of the electromagnet and spring which alternately reciprocate the plunger. *Patent 2,764,098 assigned to Bendix Aviation Corp. by John W. Dickey and William J. Randolph.*

Cone-Type Compressor

Low starting torque and reduced friction losses are characteristics of a cone-type compressor utilizing a centrally supported stator of resilient material.



Circumferential outer flange on the stator divides the compressor casing into high-pressure and low-pressure chambers (right and left), permitting the high-pressure discharge to radially compress only the small end of the flexible stator. Result is to maintain high sealing efficiency between rotor and stator

Circle 662 on page 19

WECKESSER
CABLE CLIPS

of all nylon ....

for high heat or other severe conditions

of ethyl cellulose ...

for maximum economy in average conditions

Light weight, strong, chemically resistant. No short circuits, no grounds, no corrosion, no rust. Only one fastener needed Sizes to 1¼ inches. Write for free samples and price sheet.

WECKESSER COMPANY

5715 Northwest Hwy., Chicago 30, Ill.

Circle 663 on page 19

STANDARD SUPER-PRECISION Spindles LEAD THE WAY IN INDUSTRY!

STANDARD Super-Precision Spindles represent the ultimate in rugged construction, trouble-free maintenance and adaptability. In use on a thousand jobs in industry the nation over. Every Standard spindle is "checked out" electronically in our sound-, vibration-, dust-proof laboratory before approved for delivery. Write today for catalog.

Makers of more than 800 different Super-Precision Spindles for **ORIGINAL EQUIPMENT MANUFACTURERS, REBUILDERS AND USERS**

SINCE 1912

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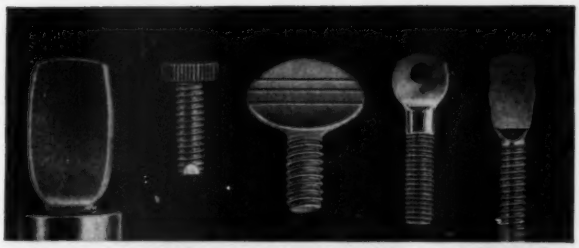
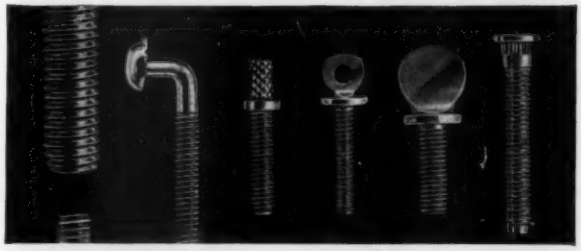
SUPER-PRECISION SPINDLE DIVISION

2501 GALVIN AVE. • CINCINNATI 4, OHIO

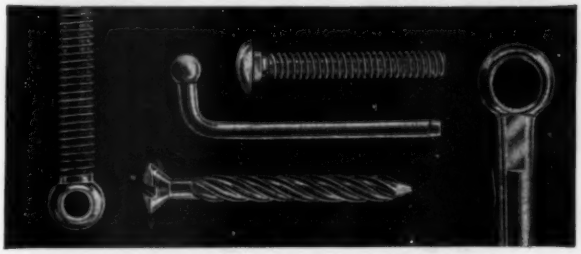
Circle 664 on page 19



YOU CAN'T BEAT COLD FORMING



FOR PARTS LIKE THESE—AND



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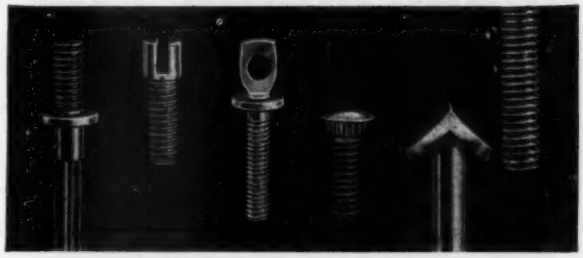
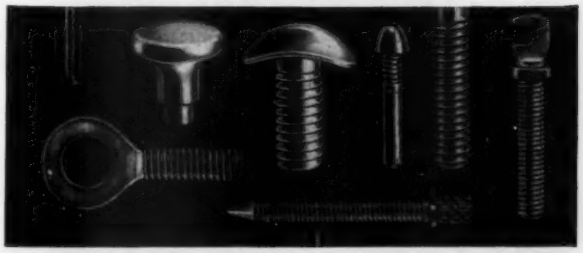


FOR COLD FORMING . . .



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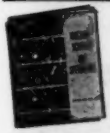


WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY

DIVISION OF THE TORRINGTON COMPANY

52 Norwood St., Torrington, Conn.

Circle 665 on page 19

The FULL-POWERED V-Type 4-Cylinder 30 hp. Model VH4

This rugged new engine has been added to the Wisconsin line to fill the horsepower gap between the Model VF4 25 hp. and the Model VG4D 36 hp. Wisconsin Engines. At the same time, the mounting base is dimensionally identical to the Models VE4 and VF4 to permit convenient replacement of the latter engines if greater power is required.

The Model VH4, which now makes its bow for the first time, is the most powerful engine of its type and size available today, in our estimation. It is an engine of basic High Torque design which gives it the important advantage of being able to deliver maximum usable *Lugging Power* that carries the load through the hard, heavy pulls. It has been designed to give you the best possible performance at all engine speeds from 1400 to 2800 rpm., even when operating under intermittent shock-loads or under constant load, continuous service.

The Model VH4 is a heavy-duty engine in all respects, built for hard service under all operating conditions, at temperatures from sub-zero to 140° F. (60° C.). It is an exceptionally smooth-running, even-firing engine and has all the traditional heavy-duty features that characterize *all* Wisconsin Models, from 3 to 36 hp. It can be supplied as an "open engine" with side-mount fuel tank, or as housed power unit and may be equipped with electric generator and starter (or starter only), clutch, reduction or clutch-reduction assemblies . . . and is adaptable to operation on a variety of fuels such as gasoline, kerosene, natural gas, Butane, Propane or fuel oil of 35 Octane rating or better.

Learn more about this new engine. Write for Bulletin S-196 for detailed data and engineering specifications.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

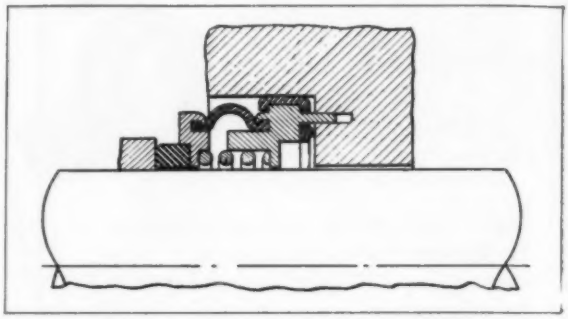
Circle 666 on page 19

Noteworthy Patents

elements while reducing friction-power losses and the size of drive motor required. *Patent* 2,765,114 *assigned to Robbins & Myers Inc. by Sheldon S. L. Chang.*

Mechanical Seal

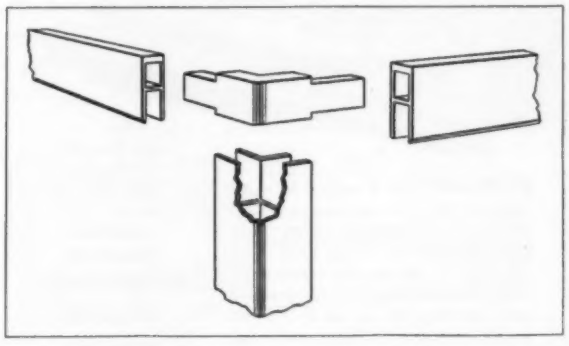
Lubricant leakage and dirt entry between rotating shafts and stationary housings are blocked by an end-face mechanical seal. Components (left to right) are an end-face sealing ring assembly, clamping ring,



flexible sleeve, seal-mounting ring, and mounting-ring gasket. Rotation of mounting ring in the housing is prevented by projecting lugs which engage matching recesses in the housing wall. Gasket-ring, which exerts high sealing pressure against the rear of the housing cavity, eliminates need for conventional, cemented-in housing gaskets. *Patent* 2,765,186 *assigned to Chicago Rawhide Mfg. Co. by Robert D. Wright.*

Corner Assembly

Construction of enclosures of all types, including instrument containers and electronic equipment cabinets, is simplified by an extruded corner assembly. Moisture-tight and shock resistant, the assembly is



suited for use with either hollow-core or solid panels. *Patent* 2,764,314 *assigned to Skydyne Inc. by Steven E. Mautner.*

Copies of patents briefed in this department may be obtained for 25 cents each from The Commissioner of Patents, Washington 25, D. C.

STOP-NUTS

Black, Self-Locking, Non-Metallic Collar

STOP-NUTS

1-Piece—All Metal

SELF-LOCKING NUTS

Free Spinning—
Locks When Seated

WING-NUTS

MACHINE-SCREW & SWITCH MOUNTING NUTS

CONDUIT LOCKNUTS

Above Nuts Supplied in STEEL • BRASS • ALUMINUM • STAINLESS

Special nuts of many types in stock

JACOBSON NUT MFG. CORP.

Kenilworth 13, New Jersey

Circle 667 on page 19

Here's the Answer to Accurate Timing of Electrically Operated Equipment

ZENITH INTERVAL TIMER

Especially recommended for operation of blowers, pumps, agitators, mixers, conveyors and other machinery . . . widely used for plastic moulding, rubber curing, heat treating, enamel baking, light exposure and similar operations.

Fully enclosed. Double-throw, single-pole switch. Self-starting slow speed industrial type synchronous motor. Time range: 60 seconds to 72 hours.

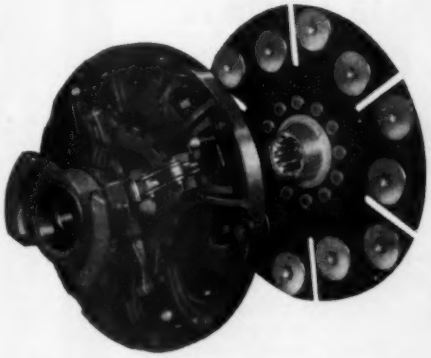
Send for full information, including bulletin on Zenith's complete line of automatic control equipment.

ZENITH ELECTRIC CO.

149 WEST WALTON STREET • CHICAGO 10, ILLINOIS

Circle 668 on page 19

ROCKFORD NEW!



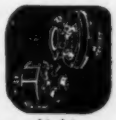
Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center



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Power Take-Offs

Speed Reducers

AIR-FLOW

Heavy Duty • Over Center

CLUTCH

with MORLIFE® Clutch Plate

This *new* AIR-FLOW type clutch was designed to provide unusual air cooling qualities. Increased torque capacity is obtained with the Morlife clutch plate. Levers are counterbalanced to eliminate self-engaging tendencies, when the clutch is idling. An unique spring-loaded feature greatly reduces frequency of adjustment. For information how this *new* Rockford AIR-FLOW clutch, with Morlife plate, will improve the operation and increase the on-the-job hours of your heavy-duty machines, write—

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Clutch Division

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B. W. ENGINEERING MAKES IT WORK
ENGINEERING
B-W
PRODUCTION
B. W. PRODUCTION MAKES IT AVAILABLE

CLUTCHES

Circle 669 on page 19

NEW

Circle Hose Clamp... Speed, Cost & Appearance Convince Design Engineers

And CIRCLE CLAMPS provide clamping action equal to or better than any clamp available today. Actual performance and pressure tests are proving to manufacturers across the country that this new type clamp is superior to the clamps they were using. Circle Clamps in a wide range of sizes are proving lower in initial cost, faster mounting, easier to replace in the field, and neater in appearance. They accommodate all hose variations.

This Indiana manufacturer switched to Circle Clamps for its lab Manometer (right) to assure positive, non-slip holding action. Clamp assembly time of a welding gun (below) was cut from 12 to 3 seconds and maintenance almost eliminated by a New York manufacturer.

Write for complete descriptive information, stock sizes, prices and the name of your nearby Circle Clamp Distributor.

Circle Clamp Corporation
39 Broadway, New York 6, N.Y.

2 SECOND INSTALLATION: OFF IN 1 SECOND

Circle 670 on page 19

NEW APPLICATIONS AND SAMPLES OF INDUSTRIAL FELT*

*made to S.A.E. and Federal Govt. Specifications

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CONTINENTAL FELT COMPANY, INC. 1903
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Circle 671 on page 19

Meter-Relays, VHS Relays, Simplytrol and Versatrol Automatic Controls, Panel Meters and Indicating Pyrometers

40 PAGE ASSEMBLY PRODUCTS CATALOG 4-A

Contents include:

"Circuitry"—6 pages of diagrams and text, including response time tables and discussion on non-locking contacts.

Ordering information.

Prices and detailed specifications for:
Clear plastic, black bakelite and ruggedized-sealed styles of:
- Meter-relays
- Indicating meters
- Indicating pyrometers

VHS Relays

Plug-in relays, power supplies

Automatic pyrometers

Automatic control packages and components

Bearing monitors

Oven pyrometers and millivoltmeters

Kiln pyrometers

Shunts

Transformers

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Assembly Products, Inc.
Chesterland 51, Ohio
HAmilton 3-4436
(West Coast: Desert Hot Springs 51, Calif. Phone 4-3133 or 4-2453.)

Meter-relays provide control of mechanical operations or chemical processes through alarm and automatic shut-off, or continuous on-off control. Applications include: Bearing temperature alarm and shut-off on pumps, turbines, generators. Automatic speed controls for machines and conveyors. Computer shut-off if power supply voltage varies. Warning and control in radiation measuring equipment and processes. Automatic switching of standby equipment in microwave communications. Continuous control of pH. Signal detection in radar warning systems.

Circle 672 on page 19

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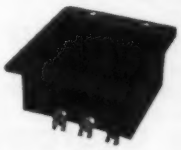
For HEAVY DUTY WORK!
Severest Electrical Services

P-506-CE—Plug with Cap

JONES PLUGS & SOCKETS
500 SERIES
Proven Quality!



S-506-DB
Socket with deep Bracket

For 5,000 Volts, 25 Amperes per Contact Alterable by circuit Characteristics.

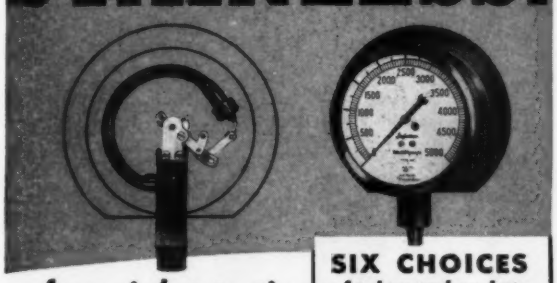
Socket contacts of phosphor bronze, knife-switch type, cadmium plated. Plug contacts hard brass, cadmium plated. Made in 2, 4, 6, 8, 10 and 12 contacts. Plugs and sockets polarized. Long-leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized *(rust-proofed)*. Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

Write for Jones BULLETIN 21 for full details on line.

Jones
HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP

Circle 673 on page 19

STAINLESS!



—from inlet to tip

Now the superlative Mastergauge is available in a wider range of corrosion resistant tubes and sockets than any other pressure gauge.

Check the adjoining list. And remember that tube socket and tip are fused into one piece by the exclusive Marsh "Conoweld" process.

Marsh alone combines the "Conoweld" construction, the copper-clad "Marshalloy" case, the finer Mastergauge movement, the Marsh "Recalibrator", the new "Safecase." Ask for data covering your specific needs.

SIX CHOICES
of tubes and sockets

4130 alloy steel tube with alloy steel tip and socket.

403 stainless steel tube with alloy steel tip and socket.

403 stainless steel tube with 416 stainless tip and socket.

316 stainless steel tube with alloy steel tip and socket.

316 stainless steel tube with 303 stainless tip and socket.

"K" Monel tube with alloy steel tip and socket.

MARSH INSTRUMENT CO., *Sales affiliate of Jas. P. Marsh Corp.* Dept. B, Skokie, Ill.
Marsh Instrument & Valve Co., (Can.) Ltd. • 8407 103rd St., Edmonton, Alberta, Can.

MARSH "THE STANDARD OF ACCURACY"

Circle 674 on page 19

overcome
power-spring hurdles

with **SANDSTEEL**
crosscurved mainsprings

Obstacles to a quality product, from the product engineer's standpoint, can often be overcome with the kind of reserve power *built into* Sandsteel mainsprings with the famous *Crosscurving* process. Only highest-quality Swedish steel can be used for this concave-convex construction that enables the use of longer, thinner springs... while assuring the reserve power needed and a longer, more even delivery of energy.

If you are designing a product requiring a flat-type mainspring, find out how Sandsteel Crosscurving can help you.

Write for FREE LITERATURE (Springs for Your Product) and CASE FILE, Dept. 35.

SANDVIK STEEL, INC.
Sandsteel Spring Division
Fair Lawn, N. J.

Circle 675 on page 19

Low-cost ACORN LOCK NUTS

Self-locking action assures tight assemblies

TYPE C (closed top)
Pleasing dome appearance

Dress up your product

Hold tight under vibration

PALNUT Acorn Types cost much less than ordinary acorn or cap nuts and have a built-in spring locking action that keeps parts tight without lockwashers. Light in weight—speedily applied with hand or power tools. Many sizes and finishes.

TYPE CK (open top)
Prevailing torque

Used as a load carrying nut, Acorn Type CK holds parts tight, provides pleasing appearance, requires less critical screw lengths.

Used as an adjusting nut, prevailing torque holds tight anywhere on screw—maintains desired settings of adjusting screws.

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THE PALNUT COMPANY
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Canada: P. L. Robertson Mfg. Co., Inc., Milton, Ont.

ACORN TYPE PALNUT TRADE MARK **LOCK NUTS**

Circle 676 on page 19

chosen for this award winning design

RIGID-tex Metal adds a decorative touch to the modern styling of this sweeper, chosen to be displayed in the Good Design Exhibit, New York Museum of Modern Art.

Its mar-resistant beauty gives a product distinctive identity, taking it out of the "look-alike" class.

RIGID-tex Metal is produced in over 40 standard patterns, in any metal, finish or color. Exclusive patterns like that used above can also be developed.

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RIGID-tex METAL IT'S RIGIDIZED

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Sales Representatives in Principal Cities

Circle 677 on page 19

Hardware for the O.E.M.

The STANLEY WORKS *at your service in*

- *Designing*
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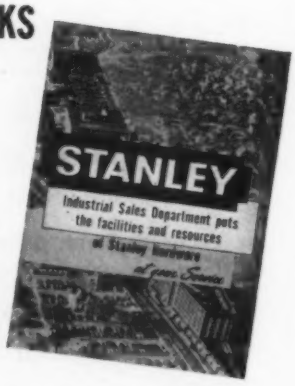
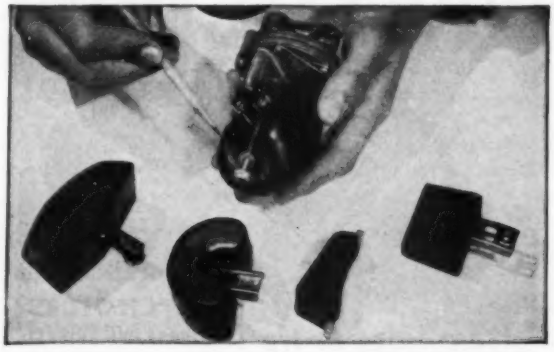


For over 100 years Stanley has been making hardware for any door that will swing, slide, lift or roll as well as a wide variety of other items.

Now a stimulating new 6-page brochure shows how Stanley's facilities, personnel and vast experience can best serve original equipment manufacturers.

Send for this folder today. It's free, of course — and it will give you fresh ideas on how you can use Stanley's exceptional knowhow in the design and manufacture of hardware and metal parts. Write Industrial Hardware Sales, 69D Lake St., New Britain, Conn. Stanley Hardware, Division of The Stanley Works.

STANLEY



Why new PARKER Floats are better than cork or metal

Better than cork! Lighter, can be used in higher temperatures. Parker sealed-cell rubber floats need no protective coating, are resistant to fungus. Won't become waterlogged. Maintain stable weight and volume.

Better than metal! New Parker sealed-cell rubber floats won't fail from vibration or punctures. Can be drilled or machined.

Where can you use them? For all types of aviation and jet fuels, oil, water, and many other liquids. Can be molded in variety of shapes and sizes, with or without metal arm.

Developed by makers of widely used Parker O-rings.

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RUBBER PRODUCTS DIVISION
Section 519-N
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio

Parker Hydraulic and fluid system components

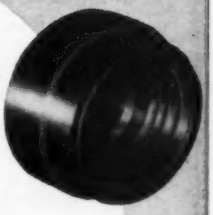
Circle 678 on page 19

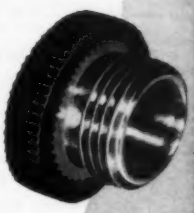
Circle 679 on page 19

XUM

PHOENIX

BRUSH HOLDER CAPS





Phoenix can furnish brush holder caps for virtually any conceivable brush holder—and at prices most motor makers find less than their own manufacturing costs.

Send your cap print or a sketch for prompt quotation on uniformly accurate brush holder caps to meet your requirements—or ask for Bulletin containing full details on the complete "standard customized" line of Phoenix Brush Holders and Caps.

Write for Bulletin 56L

PHOENIX ELECTRIC MANUFACTURING CO.
4211 West Lake Street Chicago 6, Illinois

Circle 680 on page 19

If GEARS Are YOUR Problem

We Can . . .

- act as your precision gear department
- keep your production line going smoothly without shut-downs
- reduce rejects, hand adjustments or other supervisory attention
- provide you with precise gearing for any purpose whatever
- and do it with a strict adherence to safe engineering economy

SPECIALISTS IN THE FINE PITCH FIELD

Use our more than a decade of experience in Gear making, in any material, for America's most particular users of precision or commercial gears. Send blueprints or specs for prompt estimates to

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4608 W. Fullerton Ave. • Chicago 39, Illinois

Circle 681 on page 19

ARROW

AUTOPNEUMATIC CONTROL

for Complete Conditioning and Control of Compressed Air for Powering Pneumatic Tools—Cylinders—Valves and Appliances.

PIPE LINE SIZES
¼"
⅜"
½"
¾"
1"

THE BEST IS CHEAPEST

AQUAMATIC DRAIN TRAP

- Automatically Drains Out Collected Moisture in Filter Bowl
- Visible Operation
- Non-Corrosive Parts
- Stainless Steel Valve
- Double Sump Action
- Valve Prevents Air Locks
- Adaptable to Any Make Filter with ⅛" NPT Drain Cock
- Can Be Connected to Floor Drain

QUALITY of PRODUCTS
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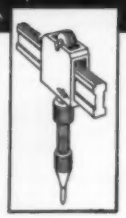

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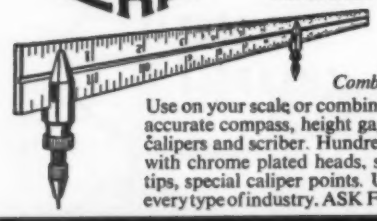

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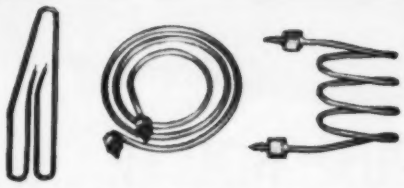

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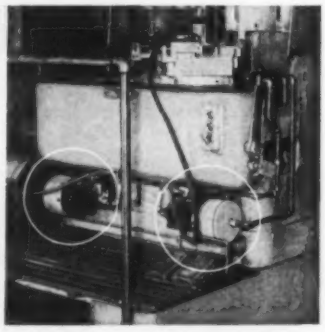

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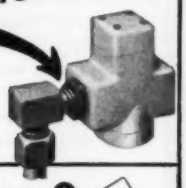

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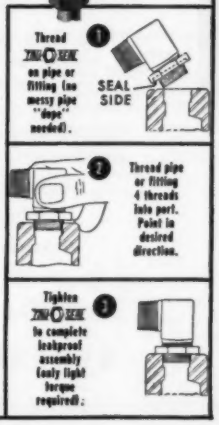
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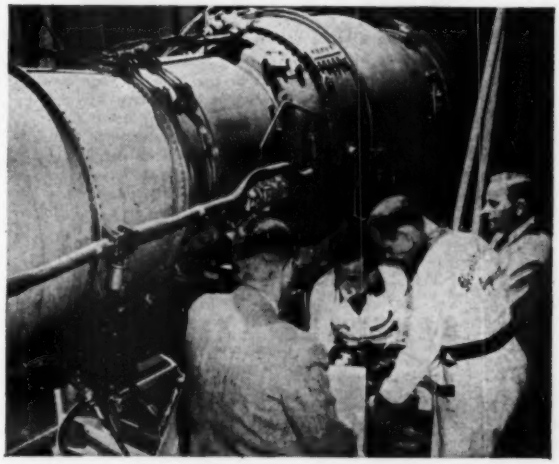

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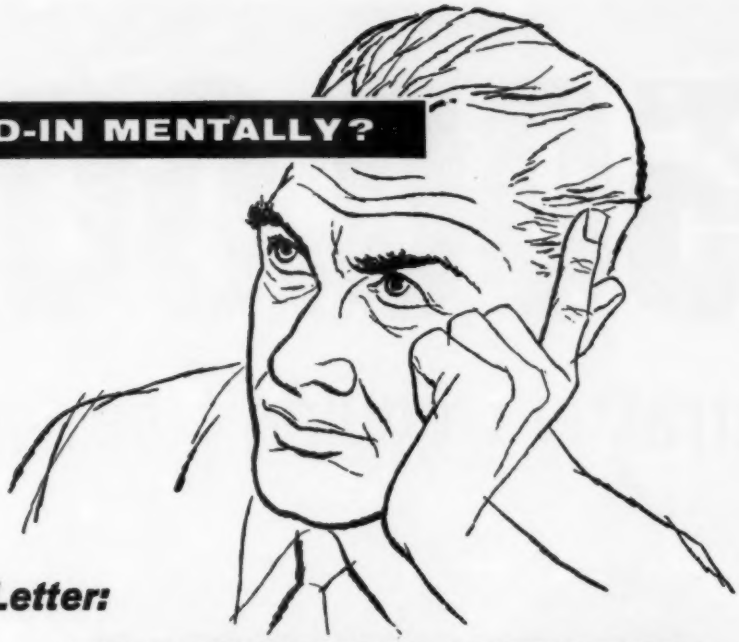

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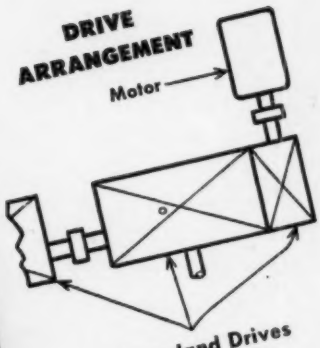
Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.



3-Cleveland Drives

Note the small overhung reducer is transmitting power to both of the larger Clevelands—a compact but powerful drive arrangement.

CLEVELAND-driven scarfer dresses beryllium-copper slabs

SPECIALLY designed to handle beryllium-copper alloys, this automatic rotary scarfer puts smooth, clean surfaces on bar stock ranging from 5/16" to 1⅛" in thickness, up to 14" wide.

Drives are Cleveland Worm Gear Speed Reducers, actuating both the rotary tooth cutter and the bar-drawing mechanism. Power from the motor is transmitted at a uniform, predetermined rate, ensuring precision in product dimensions and economy of machine operation. Furthermore, the compactness of the right-angle Cleveland drive arrangement permits important space saving in the equipment installation.

Wherever you need to operate a machine efficiently, smoothly and economically, count on using a Cleveland. Let us send you Catalog 400 and the name of our nearest representative who is prepared to help you select Clevelands best fitted to solve your transmission needs. The Cleveland Worm & Gear Company, 3287E. 80th St., Cleveland 4, O.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

Circle 502 on page 19

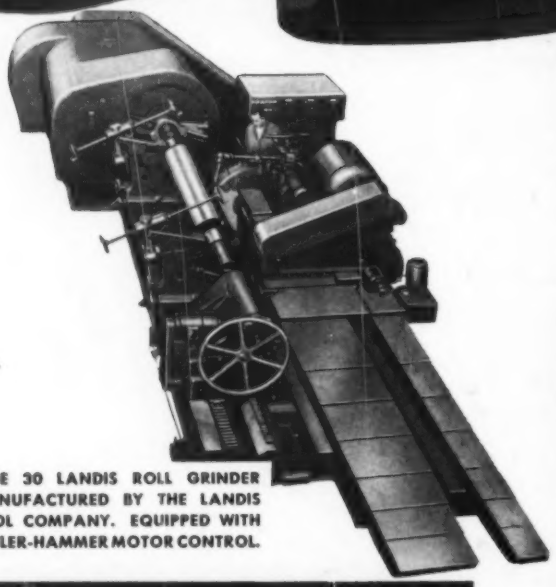
CUTLER-HAMMER

MOTOR CONTROL

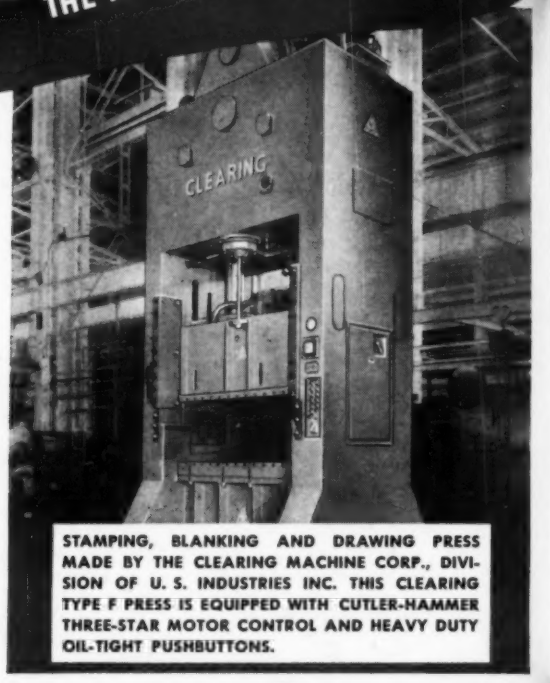
C-H

CHOICE OF THE LEADERS

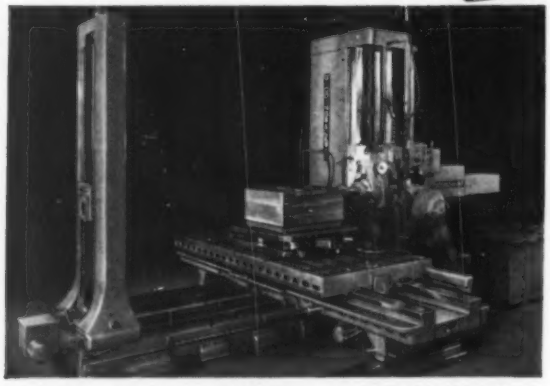
THE MARK OF BETTER MACHINES



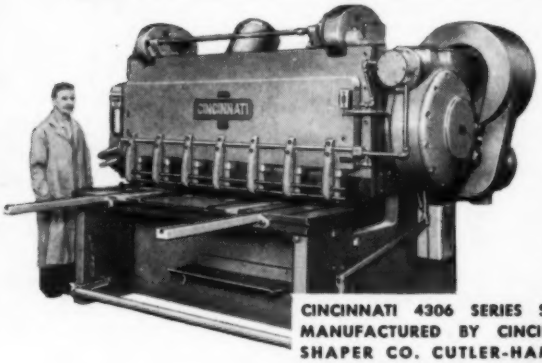
TYPE 30 LANDIS ROLL GRINDER MANUFACTURED BY THE LANDIS TOOL COMPANY. EQUIPPED WITH CUTLER-HAMMER MOTOR CONTROL.



STAMPING, BLANKING AND DRAWING PRESS MADE BY THE CLEARING MACHINE CORP., DIVISION OF U. S. INDUSTRIES INC. THIS CLEARING TYPE F PRESS IS EQUIPPED WITH CUTLER-HAMMER THREE-STAR MOTOR CONTROL AND HEAVY DUTY OIL-TIGHT PUSHBUTTONS.



THE GIDDINGS & LEWIS 30 SERIES TABLE TYPE HORIZONTAL BORING, DRILLING AND MILLING MACHINE USES CUTLER-HAMMER THREE-STAR MOTOR CONTROL AND HEAVY DUTY OIL-TIGHT PUSHBUTTONS.



CINCINNATI 4306 SERIES SHEAR MANUFACTURED BY CINCINNATI SHAPER CO. CUTLER-HAMMER MOTOR CONTROL IS FURNISHED AS ORIGINAL EQUIPMENT.

"That Something Extra"

Everyone knows, "It's that something *extra* that makes the leader." This is particularly true when you refer to the leaders among machinery builders. Leading machinery builders *must* have "that something extra" to command the respect and preference of experienced buyers. Compare any leader's machines with others and "that something extra" shows clearly in one or more ways . . . finer workmanship, greater precision, more dependable performance, new and better methods and equipment for operation and control. In recent years, more and more leaders proudly feature Cutler-Hammer Three-Star Motor Control and Heavy Duty Oil-Tight Pushbuttons. Such a marked trend could only result from careful comparison that proved a definite superiority. When you buy machines, you too will find Cutler-Hammer control equipment a reliable guide to satisfaction. Now, more than ever before, Cutler-Hammer Motor Control is the choice of the leaders . . . the mark of better machines. CUTLER-HAMMER, Inc., 1310 St. Paul Ave, nue, Milwaukee 1, Wisconsin. Associate: Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

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